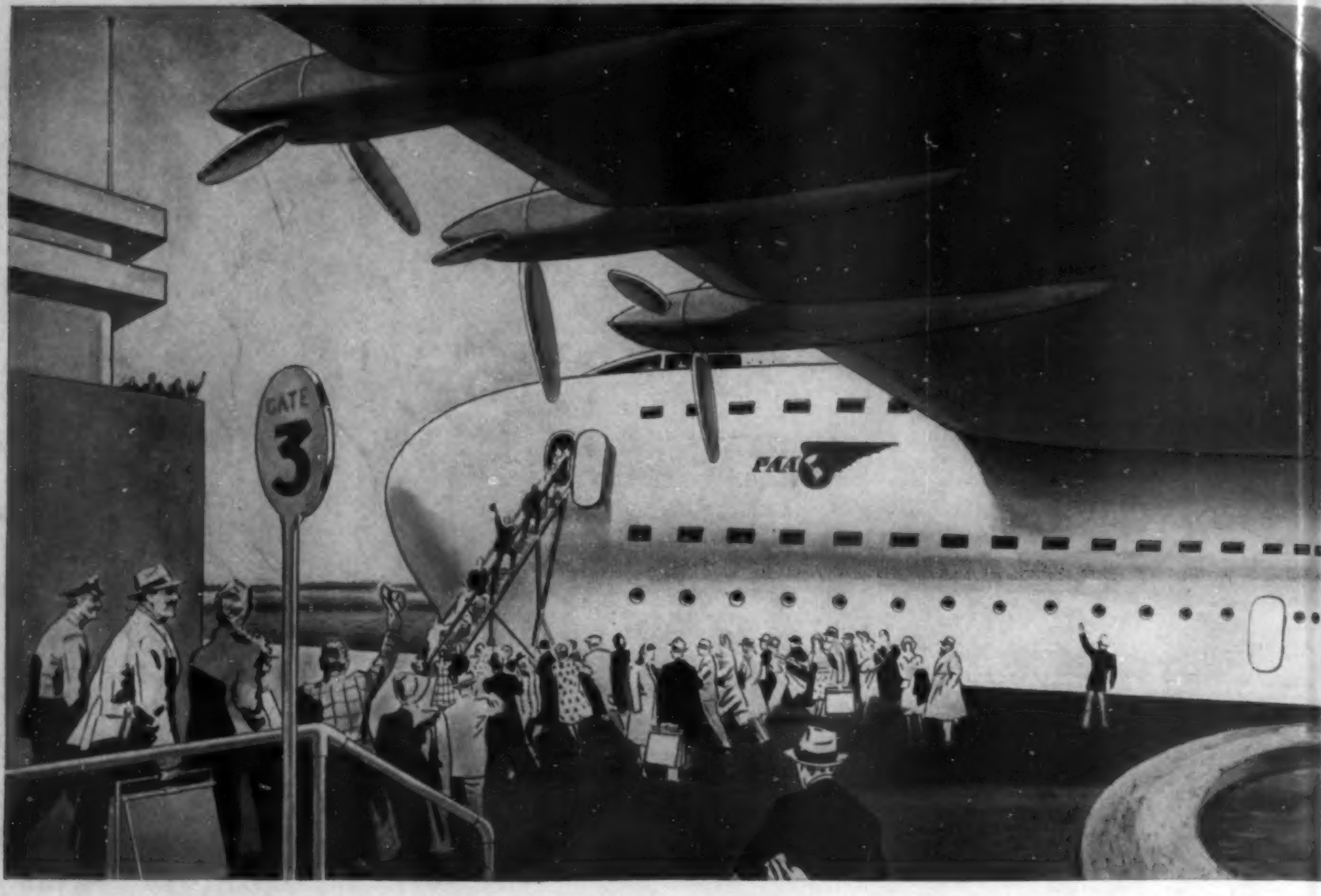
MODERN PLASTICS

DECEMBER 1943

Rendering after projected postwar Clipper by Boeing for Pan-American World Airways



How to pack for the stratosphere

WILBUR HENRY ADAMS
Industrial Designer

The Co-Ro-Lite case of this overnight bag serves as portable desk—one of Mr. Adams' luggage designs.

WE HOPE it will be a fine morning. You'll be boarding a super Clipper and remembering how true that Durez prediction was... back there in that Christmas issue of Modern Plastics, 1943.

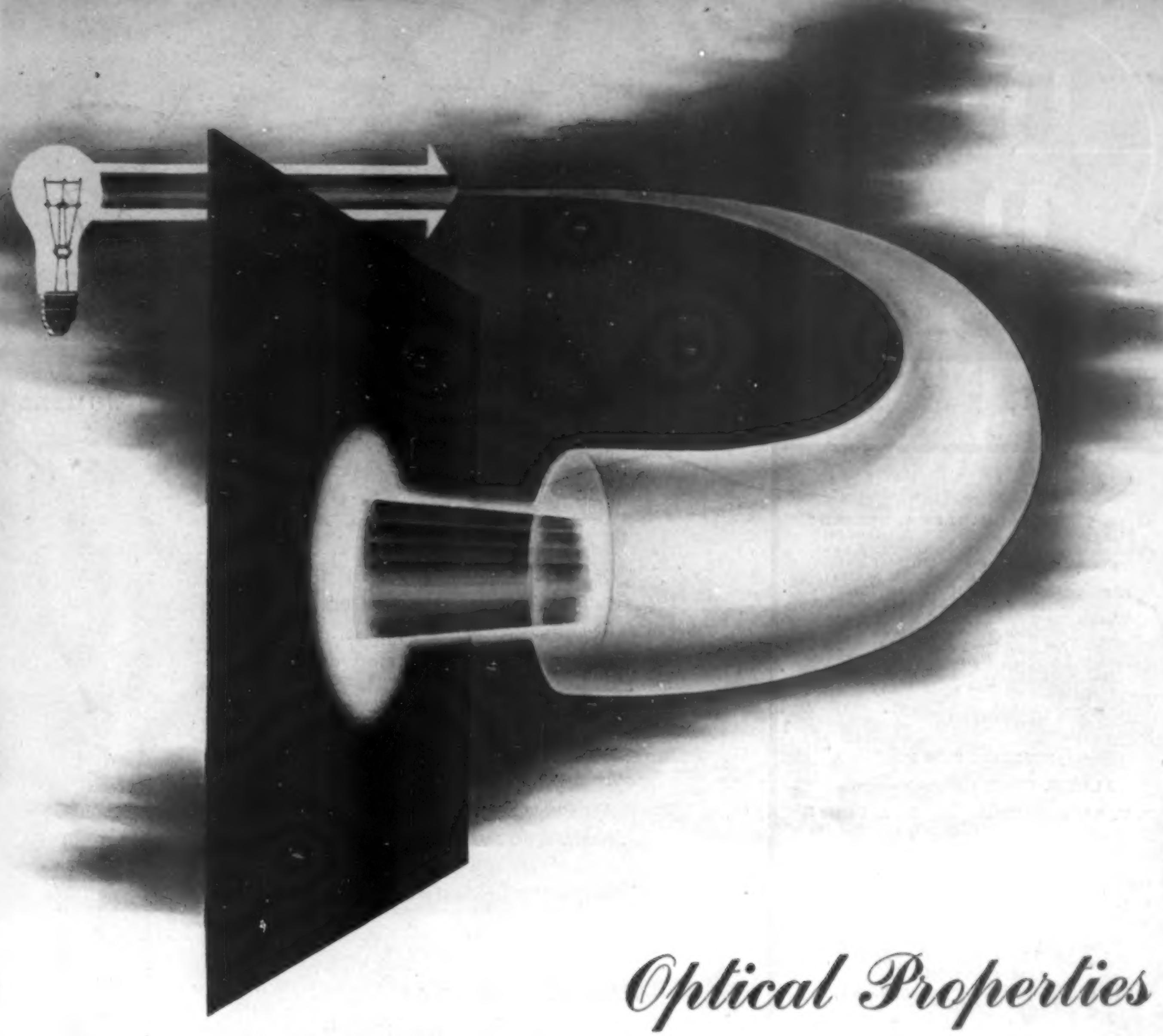
For in your hand, you'll be carrying a bag that will combine a lightness and ruggedness not available today. It will be made of Columbian Rope Company's Co-Ro-Lite, that amazing material created from sisal fibers impregnated with Durez phenolic resins. But suppose we let Mr. Adams tell you what Co-Ro-Lite can do for luggage...

"In addition to undreamed of lightness and ruggedness, Co-Ro-Lite can be molded to any shape desired. Its natural color is an integral part of the finish. Thus great production economies can be effected. In a word, luggage design can at last follow the requirements of the times. And you can design a folding case, as sketched here, for instance, that will not only carry clothes, but serve as a portable desk for busy air travelers."

TODAY, Durez resin-impregnated Co-Ro-Lite serves our air forces well. It is molded into those jettison gasoline tanks which give our fighter planes the added mileage to accompany—and protect—the big bombers on their missions.

TOMORROW, it will join you on the Clipper. Durez Plastics & Chemicals, Inc., 552 Walck Road, North Tonawanda, N. Y.

DUREZ PLASTICS THAT FIT THE JOB



Optical Properties

It kept showing up in the chemist's retort! Experimentally projected plastic formulations were revealing glass-like clarity! The chemist's bent was not in discovering substitutes for glass; his objective and his constant research were in the direction of formulating more easily molded, light weight, dimensionally stable, strong, chemically resistant materials . . . The surprising regularity, however, of this crystal-clear finding opened new gateways for study and with the result that we now have a very special group of plastic materials with very special properties.

"Loalin", a thermoplastic molding compound and "Prystal", a thermosetting phenolic, are two such materials. With both as a base, the addition of dyes produces an unlimited pallette.

In Loalin is combined the many advantages found singly in other materials. Its electrical and chemical properties are unexcelled. It is dimensionally stable, non-water absorbent . . . and is also one of the least expensive of plastic materials.

Loalin's light transmission index is 88-92%—more transparent than glass . . . It is also tougher than glass and less than half the weight. Its specific gravity is 1.054 . . . when tapped, it resounds with a glass-like ring. Its optical properties are applied to advantage in gauge crystals, aircraft instrument panels, measuring devices, etc. Loalin has a high index of refraction (1.59) and an internal reflection which gives it the unusual ability to "pipe" light beams around curves. In the field of lighting and displays, its properties open up dramatic possibilities.

Prystal, whose light transmission ranges from 80-90%, is available in the form of rods, tubes, sheets and shapes that can be machined as easily as brass or wood on standard machine shop equipment, no expensive molds being necessary.

Today, product designers and far-sighted manufacturers are planning important plastic futures . . . their drawings are exciting and original. The transparency and color, together with the physical, electrical and chemical properties of Catalin plastics are engaging the attention of these men who are preparing today, for tomorrow. Toward this preparation, Catalin offers you the cooperation and counsel of its technical staff . . . Your inquiries being sincerely invited!

Cast Resins
Molding Compounds
Liquid Resins

CATALIN
CORPORATION

ONE PARK AVENUE • NEW YORK 16, N. Y.

ONE · OF · A · SERIES ON · THE · PHYSICAL · PROPERTIES · OF · PLASTIC · MATERIALS

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Plastics ENGINEERING

VOLUME 21 — DECEMBER 1943 — NUMBER 4

● All editorial contents having bearing on military subjects have been released for publication in MODERN PLASTICS by the Armed Services.

Member Audit Bureau of Circulations

GENERAL INTEREST

PLASTICS ENGINEERING

TECHNICAL SECTION

NEWS AND FEATURES

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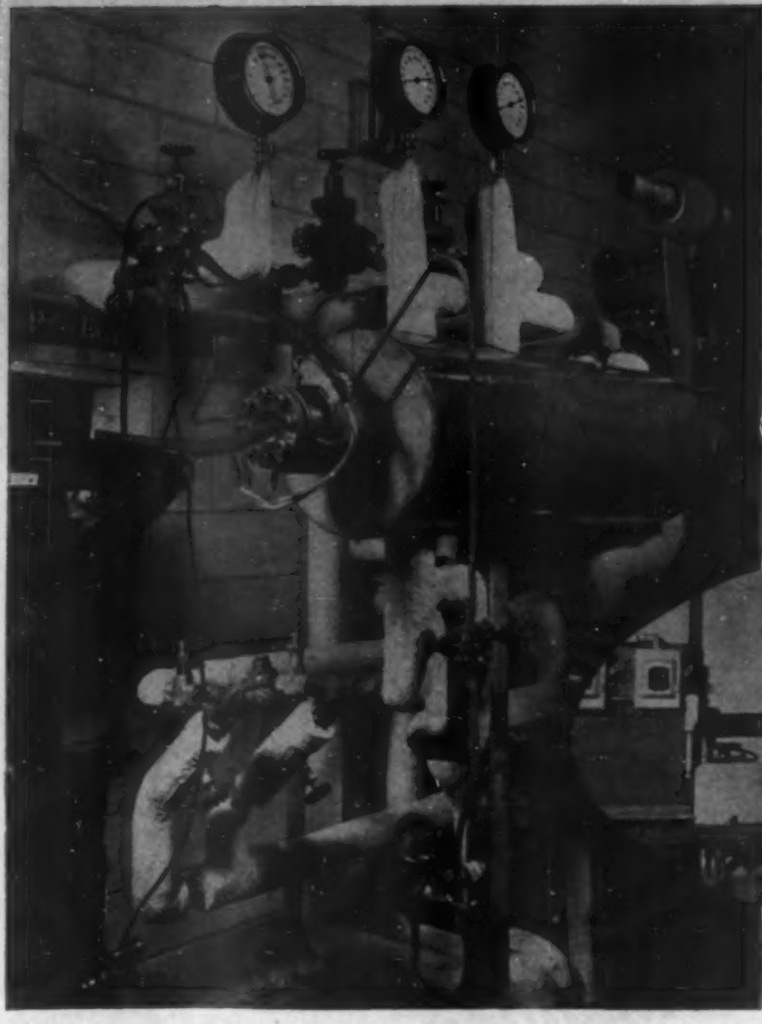
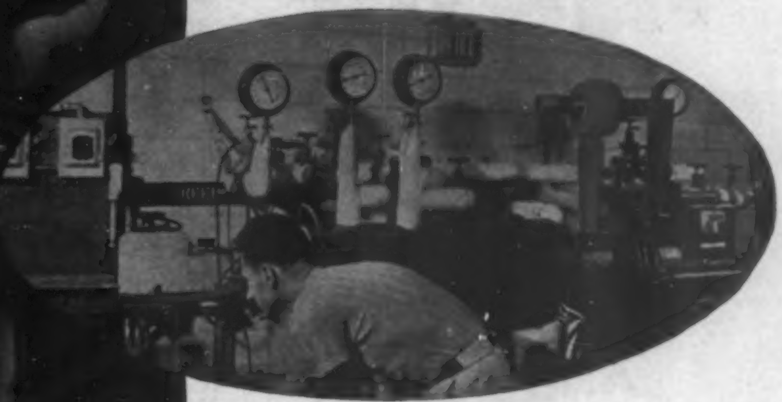
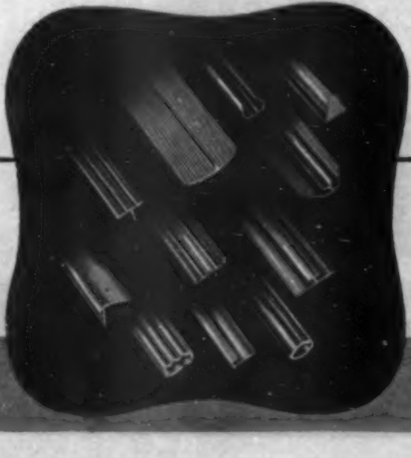






PROBLEM: To Provide Correct Humidity for Sheeting and Slitting Cellulose Acetates

SOLUTION: Carrier Air Conditioning Equipment

Here's how Carrier Air Conditioning is helping the Plastics Division of Celanese Corporation of America to improve wartime production of "Lumarith" foil.

Principal peacetime use of this product is as a transparent packaging material. In wartime it is being used extensively to make eyepieces for gas masks, as wire insulation, and as laminations for maps. It lets in light, holds in heat, and has other characteristics of glass—but does not break or shatter.

But: *During manufacturing processes this material is difficult to handle.*

The air conditioning equipment designed by Carrier engineers, (using well water instead of mechanical refrigeration) maintains correct humidity at all times in the cutting rooms and greatly facilitates sheeting and slitting operations.

This installation is the latest in a long series by Carrier for this manufacturer. The first—a unique three-stage dehumidifier—was made in 1908.

If your plant is engaged in war production and you have a problem that can be solved by the control of temperature or humidity, or both, Carrier can help you with its 35 years experience in working with the plastics industry. Our engineers will be glad to discuss the application of Carrier equipment to meet your requirements.

•

CARRIER CORPORATION, Syracuse, N. Y.

Carrier

ARMY E NAVY

AIR CONDITIONING • REFRIGERATION

INDUSTRIAL HEATING

FORTY-ONE YEARS EXPERIENCE IN INDUSTRIAL INSTALLATIONS

Richard M. Bennett examines Army water bag of Saflex-coated fabric. Pennsylvania-born, Ohio-nurtured, and Harvard-trained, he has been combining private practice with teaching at Yale and Vassar, has lately been interested in design of mass-distributed, mass-produced articles from furniture to bath fixtures and fittings.

FROM A SAFLEX ARMY WATER BAG ... A COMPACT, ALL-PURPOSE BATH UNIT

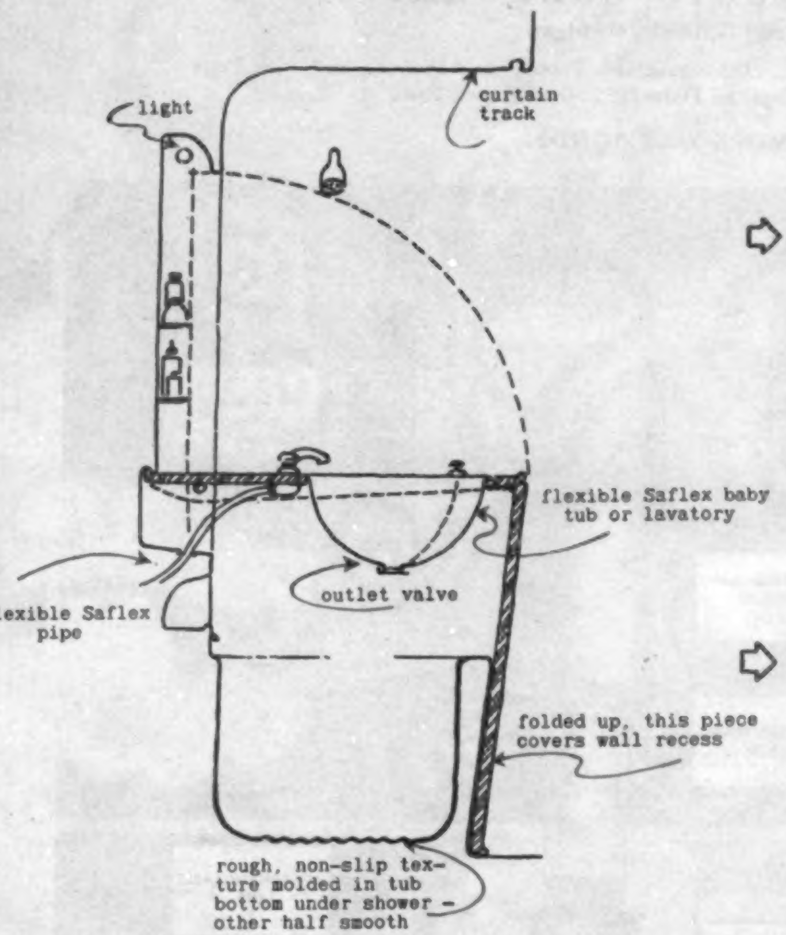
In working out his ideas for this work-and-space-saving bath unit, Architect Richard M. Bennett has taken ingenious advantage of several new war-born plastics materials and fabricating techniques.

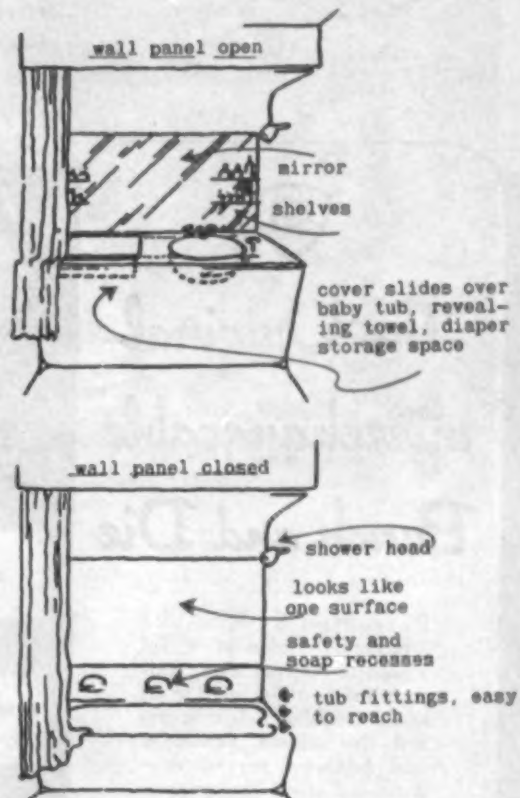
His flexible baby bath (or washbasin) and its piping make use of Monsanto's Saflex*, the prewar safety glass binder which was transformed almost overnight into the most rubber-like of modern plastics to fill the need for Army water bags and scores of similar items formerly made with rubber.

His vari-textured bath tub would be molded from amazingly strong but light-weight Resinox* impregnated pulp—a development just barely out of the laboratory stage even now.

His wall sections and most of the folding lavatory unit would be equally light, strong Resinox-bonded plywood of the types so successfully used in today's aircraft.

Finally, the surfaces of his bath tub, walls and lavatory unit would incorporate Monsanto's newly developed melamine resins so that they could be any attractive, opaque color and would be hard, durable, resistant to alkalis and boiling water yet warmly pleasant to touch.





*The Broad and Versatile Family of Monsanto Plastics

(Trade names designate Monsanto's exclusive formulations of these basic plastic materials)

LUSTRON (polystyrene) • SAFLEX (vinyl acetal) • NITRON (cellulose nitrate) • FIBESTOS (cellulose acetate) • OPALON (cast phenolic resin) RESINOX (phenolic compounds)

Sheets • Rods • Tubes • Molding Compounds • Castings • Vuepak Rigid Transparent Packaging Materials

MONSANTO PLASTICS

SERVING INDUSTRY...WHICH SERVES MANKIND

WRITE FOR FACTS ON PLASTICS

As a designer or as a sales or production executive, you may or may not be interested in the postwar bathroom. Whatever your business interests, however, you *will* want to know something about postwar plastics and their possible contributions to *your* products. That's why we suggest that you write today for the 24-page guide to Monsanto Plastics, probably the widest, most versatile group of plastics offered by any one manufacturer. Included are charts, graphs, data and many photographs to help you paint your own picture of the shape of things to come in your own particular line. MONSANTO CHEMICAL COMPANY, Plastics Division, Springfield, Massachusetts.

call it "Know How"...

There are many names for skill and experience but no substitute for the combination. Through 15 years of peacetime production, Allied Products Corporation perfected the skill of its craftsmen and the facilities of its four great plants.

Now our many skills are turned to producing the tools and dies and parts needed for war. We are proud that each of our four plants flies the Army-Navy "E" for excellence of production.

ALLIED PRODUCTS CORPORATION

Detroit and Hillsdale, Michigan

Precision Aircraft Parts . . . Plastic Molds . . . Interchangeable Punches and Dies . . . Production Parts
Sheet Metal Dies . . . Jigs and Fixtures . . . Cold Forged Parts

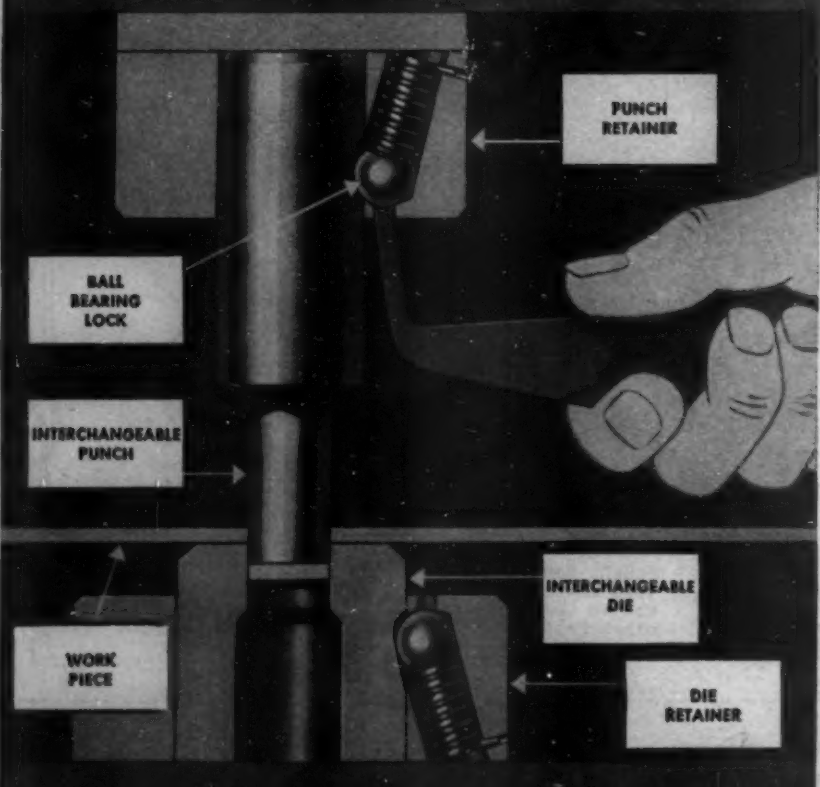
BUY MORE WAR BONDS

RB

The Original Interchangeable Punch and Die

Perfected by Richard Brothers Division of Allied Products Corporation, this unit is now widely used in all metal working fields. Standard size square, round or end retainers are of case-hardened steel. The retainer is fitted with a patented ball bearing and spring lock which holds the punch or die securely but permits easy changing without removing the die from the press. Interchangeable punches are of water-hardened steel, rigidly tested and inspected. Carried in stock in a wide range of standard sizes. Special size retainer plates, punches and dies made to order. Write for the complete R-B catalog.

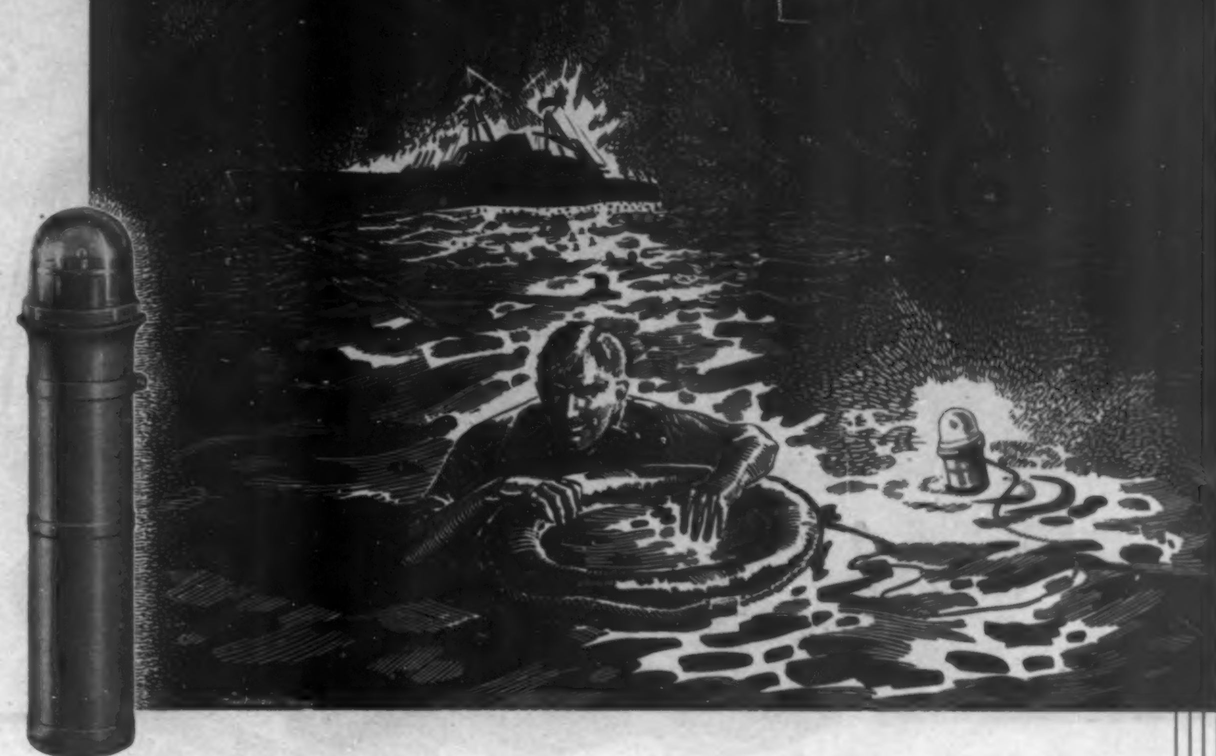
"IT'S AN ALLIED PRODUCT"



Illustrated above is a complete Richard Brothers Interchangeable Punch and Die assembly showing the method of releasing either the punch or die simply by depressing the ball bearing with the special hand tool provided.

"SERVICE WITH A PUNCH"

The Light That Did Not Fail!



AN important advance in Marine lighting is a new electric water light, used in conjunction with the life preservers and life raft equipment of our Coast Guard and Merchant Marine.

Erie Resistor engineers, in collaboration with the Coston Supply Company, succeeded in developing this new life saving device by using injection molded plastics for the greater part of the unit.

Formerly made of metal, the barrel is now injection molded of grey cellulose acetate butyrate, and the cap or dome is molded of clear hiacetyl acetate, reducing the weight of complete light to a little over three pounds, or about one fifth the weight of the usual water light.

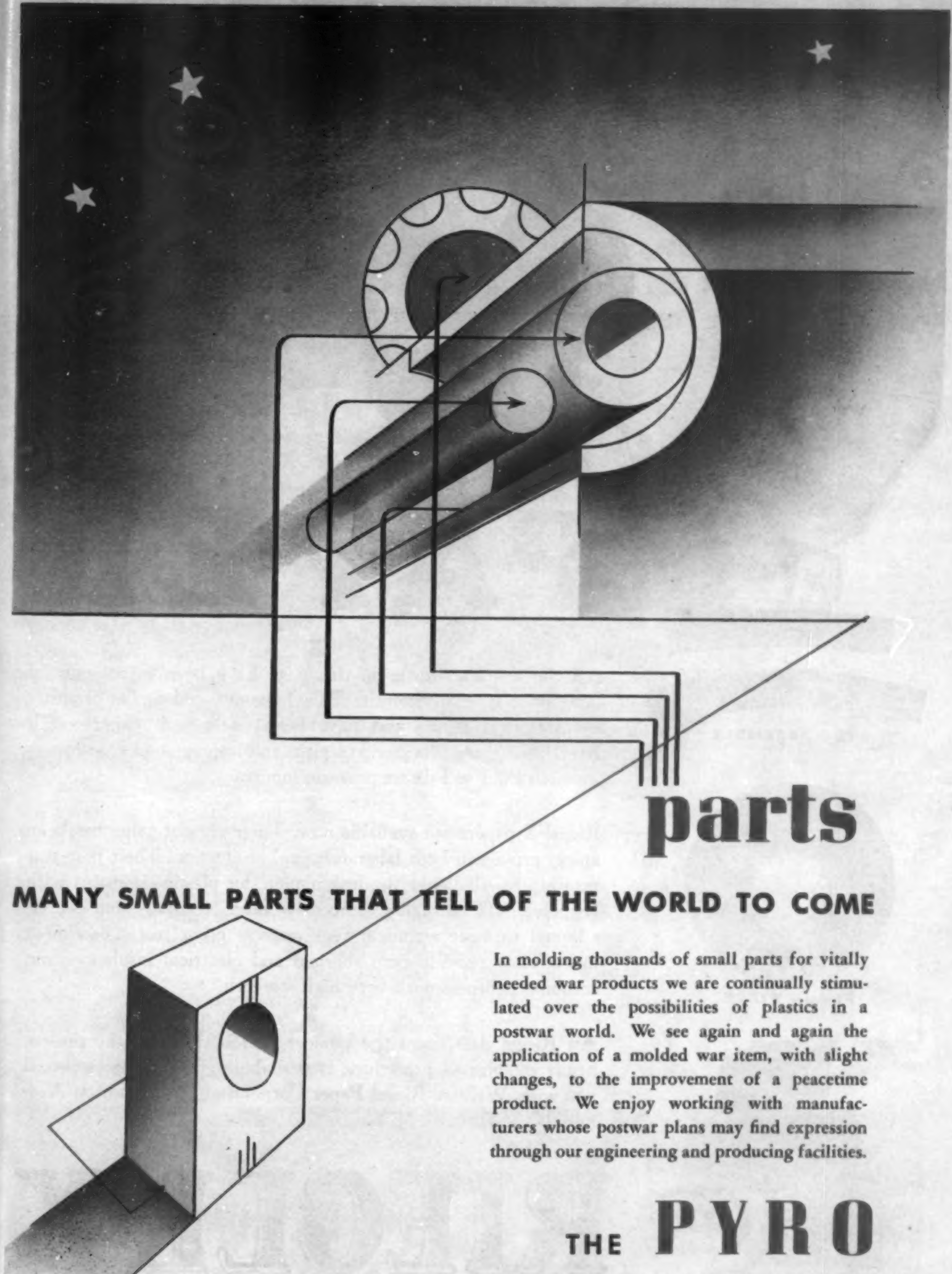
The dome, formerly machined to produce a tight fit on plastics barrel, has threads molded to very close tolerance, and together with rubber gasket, makes it absolutely water proof.

This water light is an example of how Erie Resistor combines the experienced talents of their Engineering and Molding Departments to produce molded plastic articles of mechanical strength and dimensional accuracy. Write for illustrated bulletin describing Erie Resistor Plastic Molding Facilities.

Back The Attack—With War Bonds

ER *Plastics Division* ER

ERIE RESISTOR CORPORATION, ERIE, PA.



To-morrow VICTORY and Peace

Our Christmas message is concerned with To-morrow... and all that it means. This hour... this day brings up the ultimate question, "What for To-morrow?"

All of the To-morrows depend on our efforts to-day, and the Destiny of this and the next generation depends on our ability to overcome all the grave problems which face us hourly.

This is a test of our endurance. The Blood, Sweat and Tears of all of us, the unity of purpose and the determination of a free people, will maintain the peace and the liberty of our way of life. The Reynolds organization re-dedicates itself to this task.

★

BUY WAR BONDS

Reynolds Plastics

REYNOLDS MOLDED PLASTICS
CAMBRIDGE, OHIO, U. S. A.

REYNOLDS SPRING COMPANY
JACKSON, MICHIGAN

JOHN M. DeBELL

PLASTICS CONSULTANT

LONGMEADOW, MASS.

October 26, 1943.

Mr. C. A. Breskin, Editor,
Modern Plastics,
122 E. 42nd Street,
New York City.

Dear Mr. Breskin:

Three questions before every plastics industrialist today are:

1. How can I further apply plastics towards winning the war?
2. How can I conserve man hours?
3. Without relaxing the war effort, how can I best prepare for plastics utilization after the war?

To help in developing the answers to these questions, I am glad to announce that, after December first, I shall have collaborating with me Mr. Henry M. Richardson, Consulting Engineer, of Pittsfield, Massachusetts, operating as DeBell and Richardson.

Mr. Richardson is an experienced engineer, expert in manufacturing processes, design of parts, costs, development programs, market and business analyses, quality control, process improvement and utilization of personnel. He has spent 15 years in plastics manufacture; and before electing to undertake consulting he was Chief Engineer in charge of Development, Engineering, and Quality Control for the Plastics Divisions of General Electric Company.

We shall maintain offices in Longmeadow, Mass. and Pittsfield, Mass.

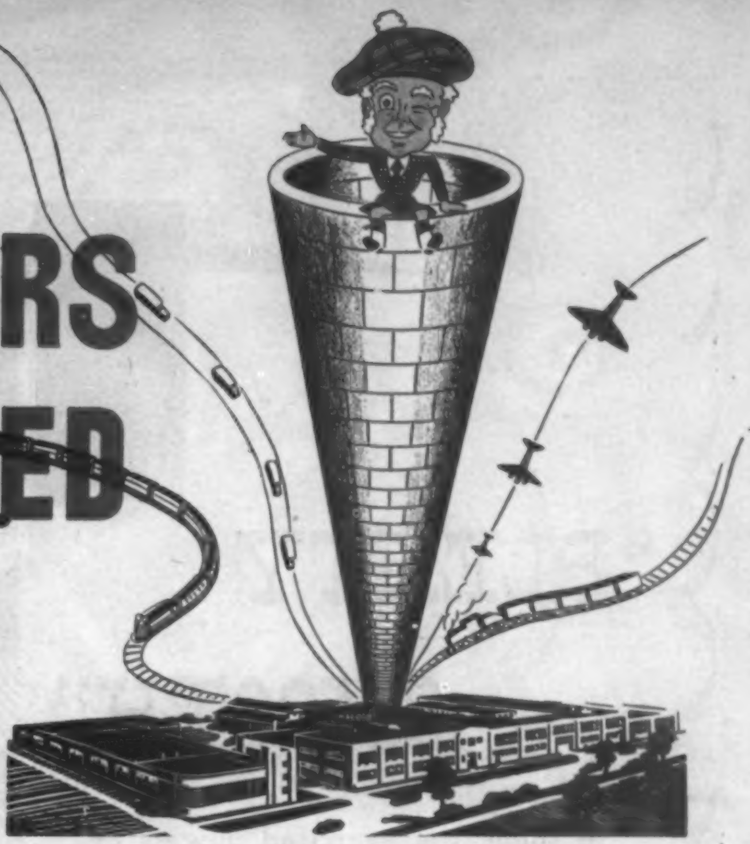
Mr. Richardson and I will be grateful if you accept this letter as a paid advertisement in Modern Plastics; assuring meticulous study of problems submitted to us and our best efforts to assist our clients in putting plastics correctly and profitably into the service of the community.

With best personal regards, I am

Sincerely yours,

John M. DeBell

SUPPLY HEADQUARTERS FOR EXTRUDED PLASTICS



The supply lines of many industries —aircraft, automotive, refrigeration, furniture—and their wartime counterparts extend straight to the MACOID plant.

From the West coast, the Eastern seaboard, from the South and Southwest these industries and many others come to DETROIT MACOID for their extruded plastic requirements.

We make rods—from hairline thickness to a solid 4″ diameter; tubes — including flexible tubing that is cold (—70° F.) and heat (plus 190° F.) resistant, and rigid tubing in a wide variety of sizes. We also supply them with an infinite variety of special shapes and profiles which are used for such diverse applications as aircraft ribs and wall stripping.

As the originator of modern (dry-process) extension of plastics, MACOID was early established as the reliable source of supply. Pioneering in new applications for all industries has kept MACOID foremost in extruded plastics.

We also do injection molding.

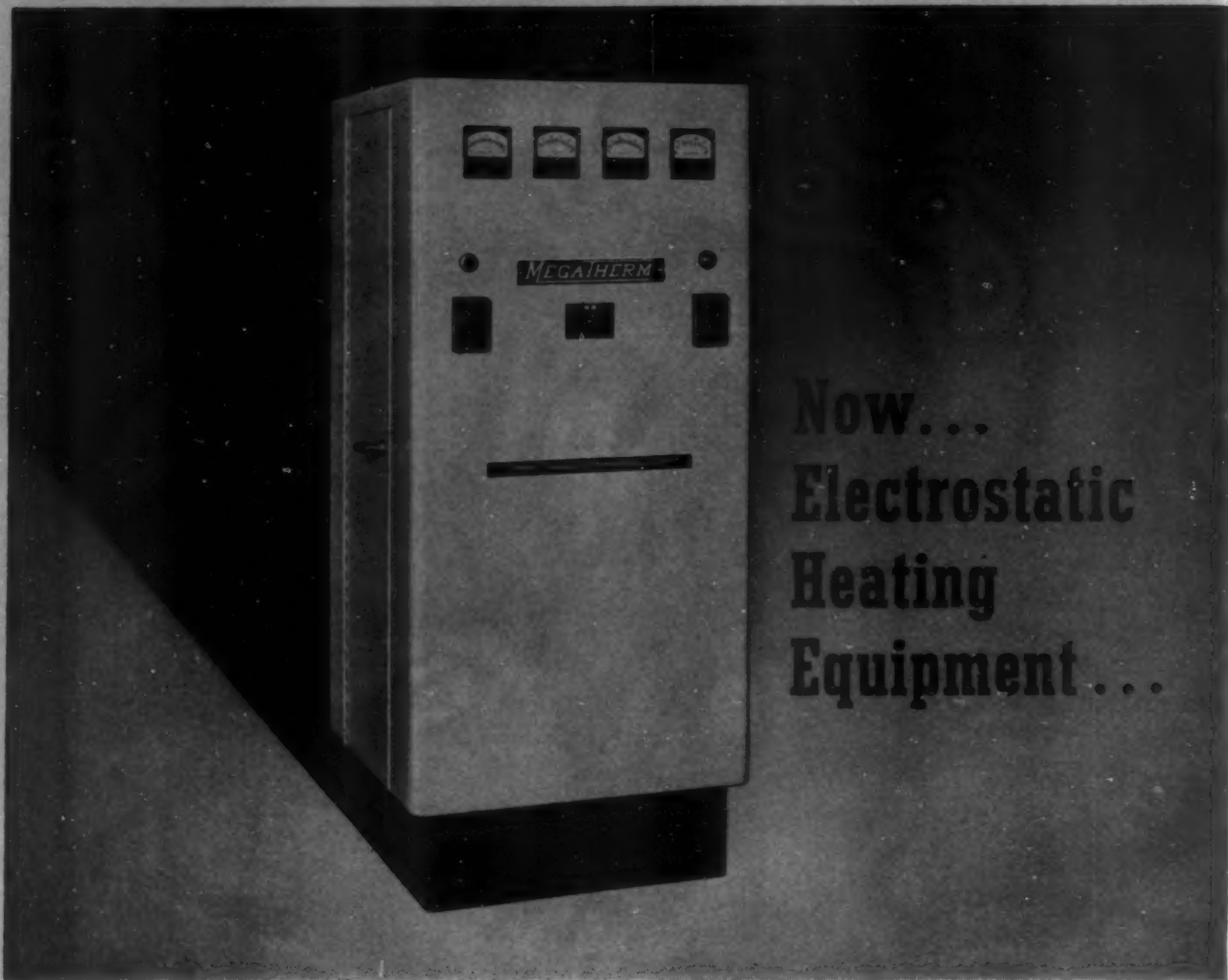
DETROIT MACOID

CORPORATION

12340 Cloverdale Ave. Detroit, Michigan

ORIGINATORS OF DRY PROCESS PLASTIC EXTRUSION


LAKE ERIE
ENGINEERING CORP.
BUFFALO, N.Y. U.S.A.
LAKE ERIE engineers are ready to assist management in developing Hydraulic Presses to solve the problems that will confront industry in a post-war world.



...Designed and Built to the Special Requirements of the Plastics Industry

RUGGED
Stands Hard Usage; 1/8" Steel Cabinet

RELIABLE
Gives Efficient, Dependable Service

PORTABLE
Easily Moved for Any Application

COMPACT
All-in-one Unit Saves Floor Space

SIMPLE
Strictly Non-technical in Operation

SPEEDY
Increases Production

ECONOMICAL
Reduces Heating Time and Die Costs

SAFE
Complete Protection for Operator

In pioneering megacycle radio energy for industrial use, Federal has developed an application for Plastics processing that is unique both in conception and performance.

Through its Megatherm equipment it has put radio frequency heating on a practical basis, which assures perfect molding at low pressures, prevents breakage of die inserts, reduces curing time from minutes to seconds and provides uniformity, speed and economy.

Constructed along the same lines as any other machine tool, Megatherm equipment is installed without change in plant layout. It is ready for operation — merely has to be set alongside press and started to work for double or triple production. Simplicity of the unit eliminates tuning or other adjustment. It is controlled by two push buttons, with foot switch optional, and can be operated by unskilled, untrained help.

Megatherm will give you greater production at less cost.

We shall be glad to discuss it with you in terms of your requirements.

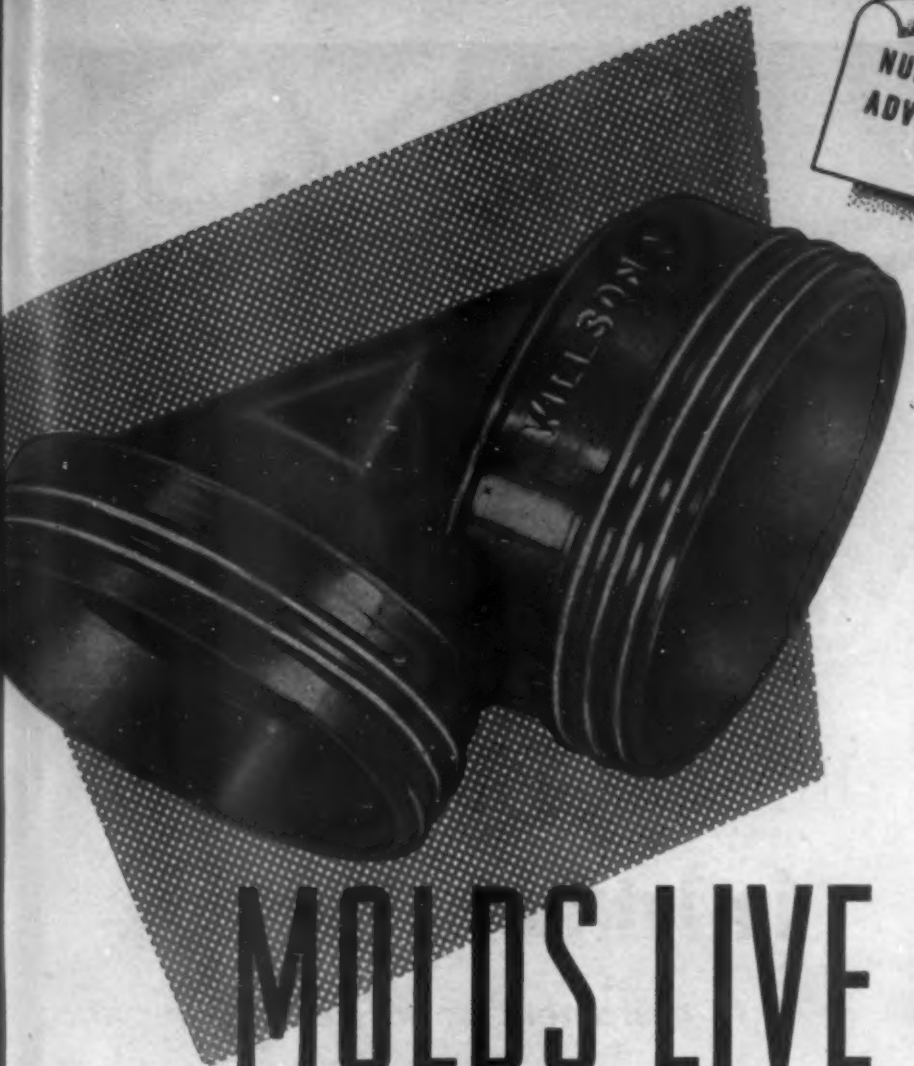
-MEGATHERM-

Federal Telephone and Radio Corporation

INDUSTRIAL ELECTRONICS PRODUCT DIVISION, Newark, New Jersey

AN IT&T ASSOCIATE

NUMBER 6 IN A SERIES OF EDUCATIONAL ADVERTISEMENTS ON TRANSFER MOLDING



MOLDS LIVE LONGER

The life of a mold used in TRANSFER MOLDING is measurably longer than the useful span of an ordinary compression mold.

The reason is that the material is brought to a soft plastic state before entering the mold cavity thereby resulting in substantially reduced wear and breakage.

Under war conditions the factor of longer mold life means much in conservation of metals and skilled manpower. At all times it has a cost-lowering effect on plastics molded by the TRANSFER method. This is another of the reasons for the ever-widening adoption of TRANSFER MOLDING.

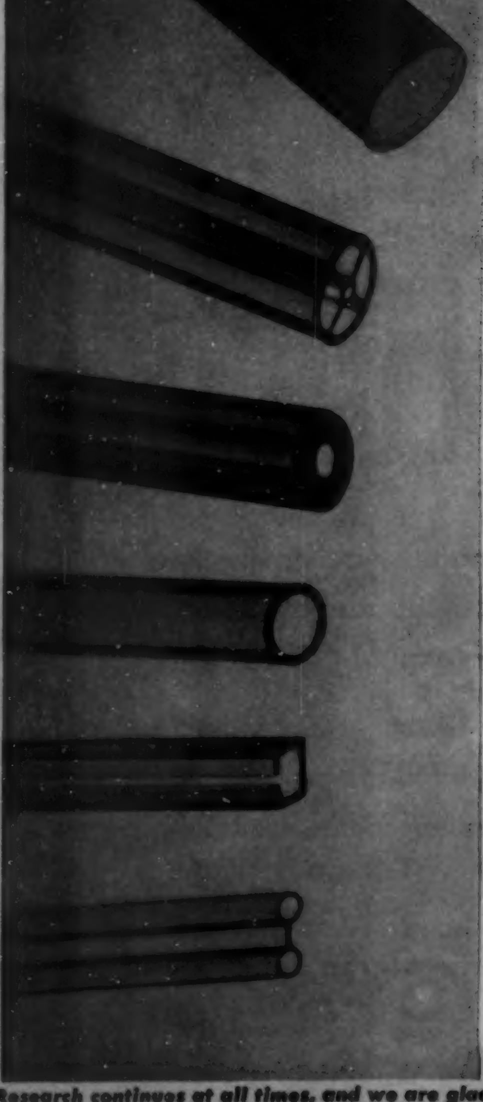
TRANSFER MOLDING *is the best way to*

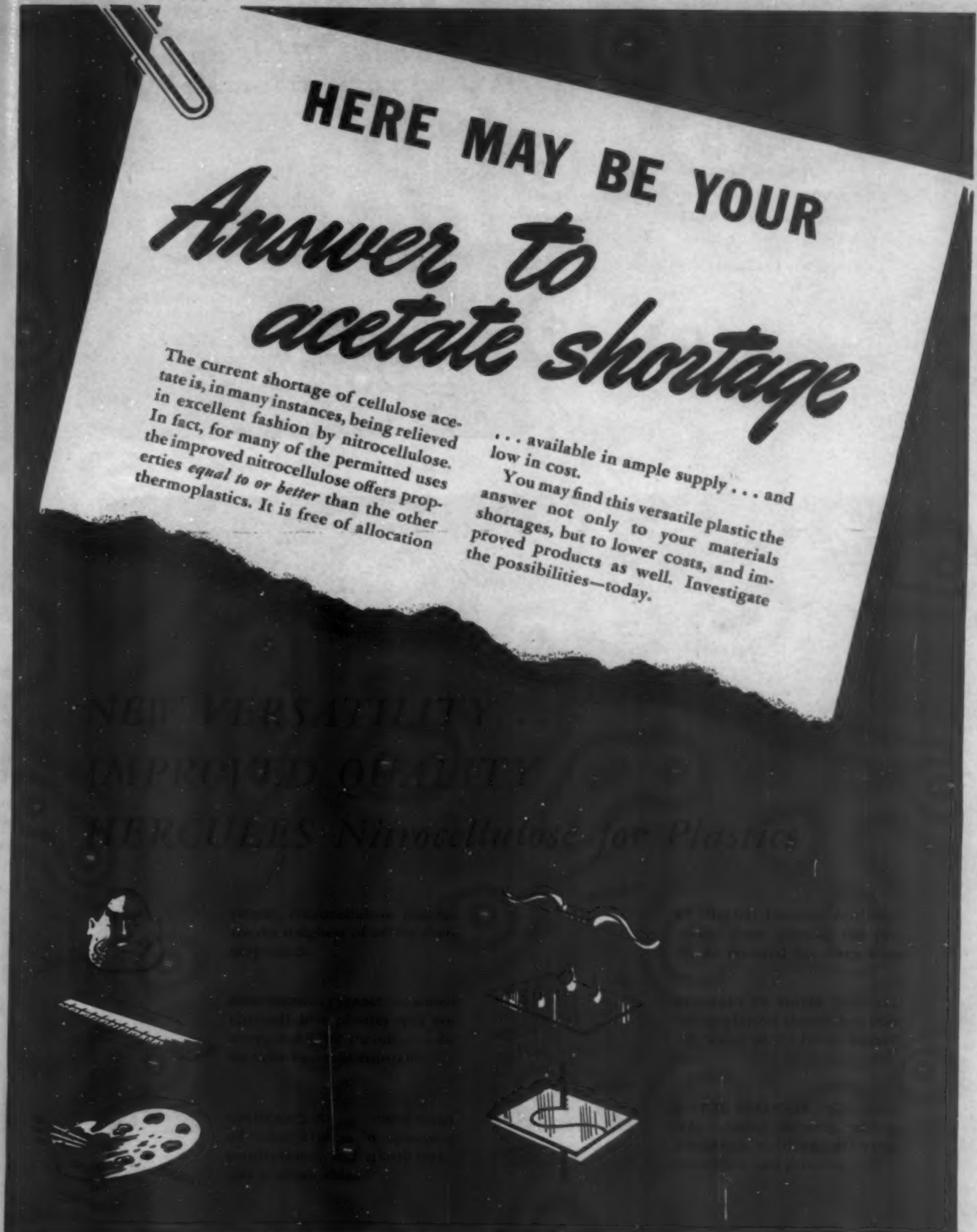
- Handle inserts—metal, glass, ceramic
- Mold high-impact materials
- Mold unsupported cores
- Achieve maximum dimensional accuracy
- Reduce trapped gases
- Lower mold costs
- Lengthen mold life
- Increase molding speed
- Reduce finishing costs
- Improve uniformity of cure regardless of cross-section
- Save material by eliminating flash
- Get practical solution to difficult molding problems

—on thermosetting plastics.

SHAW INSULATOR CO.

IRVINGTON SHAW NEW JERSEY



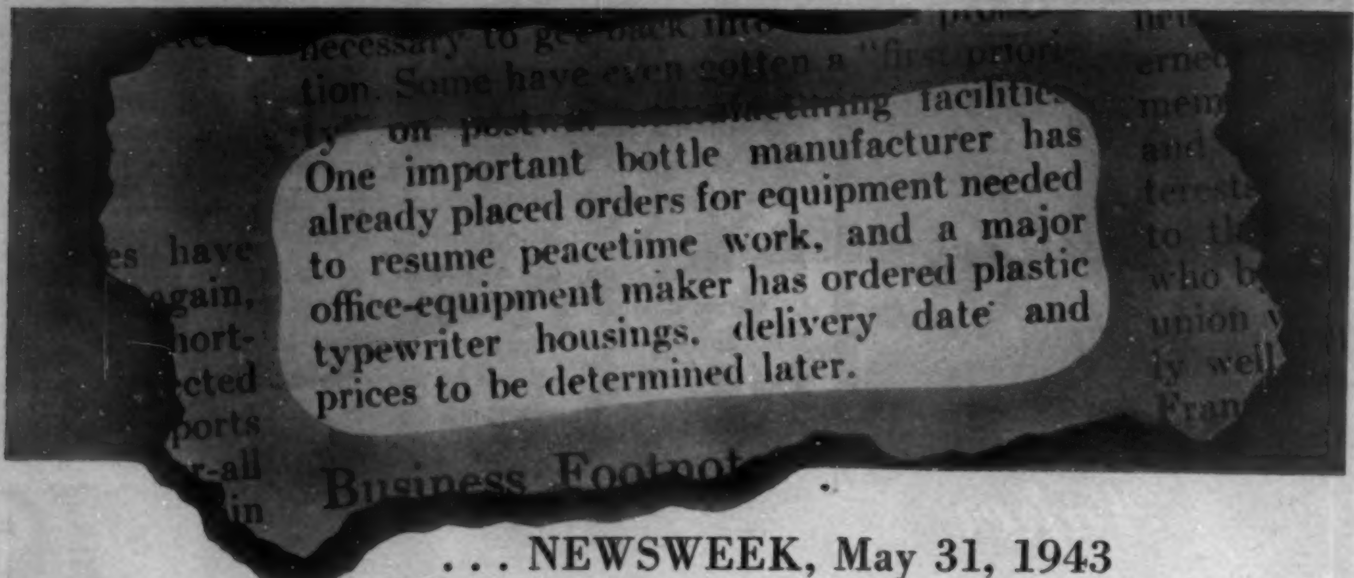

HERE MAY BE YOUR
Answer to acetate shortage
The current shortage of cellulose acetate is, in many instances, being relieved in excellent fashion by nitrocellulose. In fact, for many of the permitted uses the improved nitrocellulose offers properties *equal to or better* than the other thermoplastics. It is free of allocation
. . . available in ample supply . . . and low in cost.
You may find this versatile plastic the answer not only to your materials shortages, but to lower costs, and improved products as well. Investigate the possibilities—today.
NEW VERSATILITY . . .
IMPROVED QUALITY
HERCULES Nitrocellulose for Plastics

Angle Molding Press for Thermo-Setting Materials

All enclosed for safety as well as appearance, this angle molding press is provided with electrical devices and timers for over all operation. It is equipped with push button stations for stopping in emergencies and hand-controls for mold setting. It automatically operates each ram and controls each movement for proper sequence and possesses variable timing for curing. *The Baldwin Locomotive Works, Baldwin Southwark Division, Philadelphia, Penna., U. S. A.; Pacific Coast Representative, The Pelton Water Wheel Co., San Francisco.*

BLW THE BALDWIN GROUP

BALDWIN
SOUTHWARK
HYDRAULIC PRESSES



. . . NEWSWEEK, May 31, 1943

THE man is not our customer, but we'd like to know him. He's the kind of man—the only kind—we can talk to now.

We don't think it's too early for postwar planning. The war is coming into some measurable perspective with Allied victories exploding around the globe. We have an idea peace may occur suddenly.

Men with at least blueprints for the solutions of their post-war problems will be jumps ahead of the mob when it does come along.

If you've been thinking along these lines, we'd like to compare notes with you. If you're thinking plastics as they will—or can—be made, we'd like to know you. Drop us a line and perhaps we can get together.

"A Ready Reference for Plastics" written for the layman, is now in its sixth edition. If you are a user or a potential user of molded plastics, write us on your letterhead for a copy of this plain non-technical explanation of their uses and characteristics. Free to business firms and government services.

ARMY E NAVY

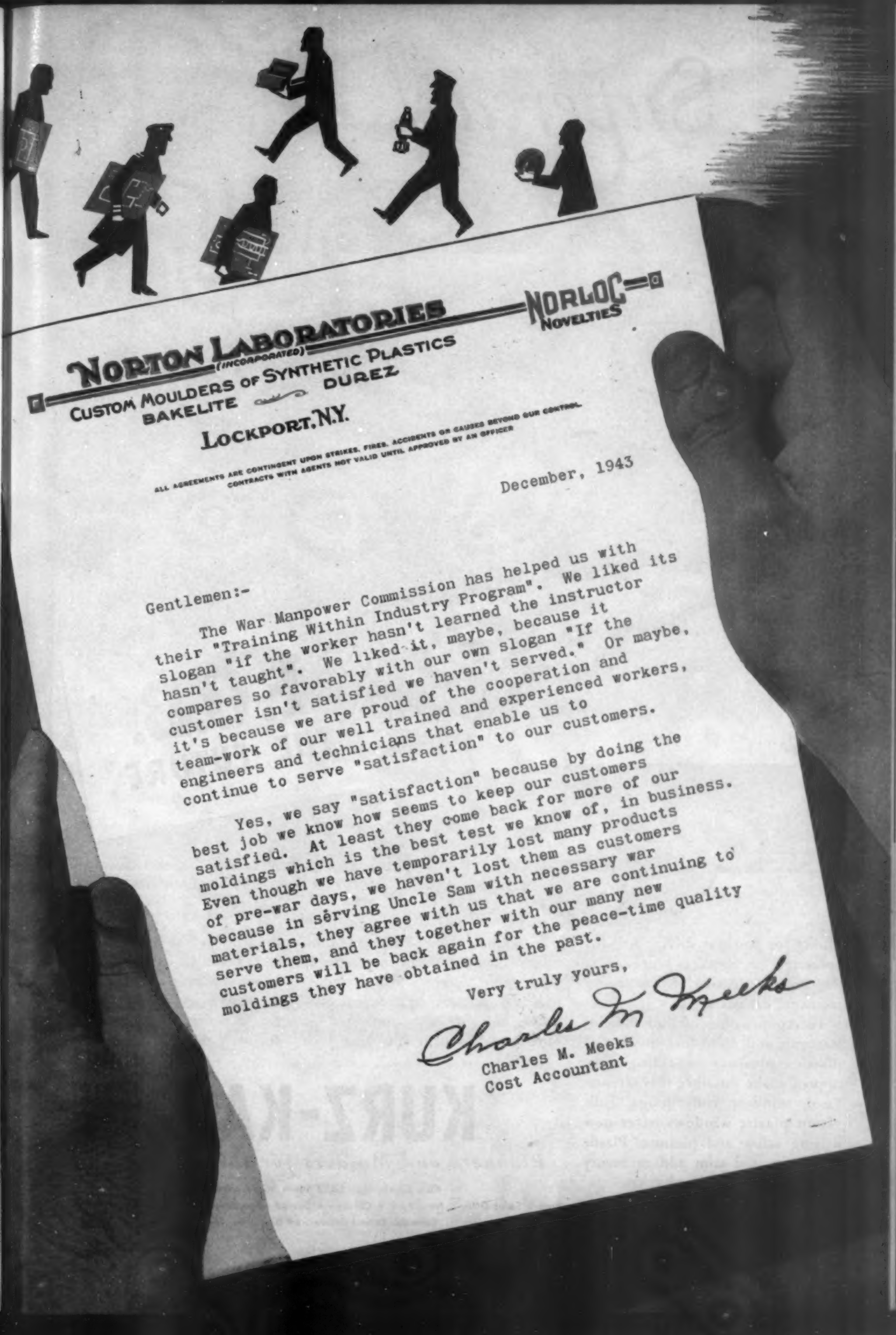
BOONTON MOLDING COMPANY

MOLDERS OF PLASTICS · PHENOLICS · UREAS · THERMO PLASTICS

BOONTON · NEW JERSEY · Tel. Boonton 8-2020

NEW YORK OFFICE

Chanin Bldg., 122 East 42nd Street, New York 17, N. Y., MUrray Hill 6-8540



NORTON LABORATORIES (INCORPORATED)

NORLOC NOVELTIES

CUSTOM MOULDERS OF SYNTHETIC PLASTICS

BAKELITE — DUREZ

LOCKPORT, N.Y.

ALL AGREEMENTS ARE CONTINGENT UPON STRIKES, FIRES, ACCIDENTS OR CAUSES BEYOND OUR CONTROL
CONTRACTS WITH AGENTS NOT VALID UNTIL APPROVED BY AN OFFICER

December, 1943

Gentlemen:-

The War Manpower Commission has helped us with their "Training Within Industry Program". We liked its slogan "if the worker hasn't learned the instructor hasn't taught". We liked it, maybe, because it compares so favorably with our own slogan "If the customer isn't satisfied we haven't served." Or maybe, it's because we are proud of the cooperation and team-work of our well trained and experienced workers, engineers and technicians that enable us to continue to serve "satisfaction" to our customers.

Yes, we say "satisfaction" because by doing the best job we know how seems to keep our customers satisfied. At least they come back for more of our moldings which is the best test we know of, in business. Even though we have temporarily lost many products of pre-war days, we haven't lost them as customers because in serving Uncle Sam with necessary war materials, they agree with us that we are continuing to serve them, and they together with our many new customers will be back again for the peace-time quality moldings they have obtained in the past.

Very truly yours,

Charles M. Meeks

Charles M. Meeks
Cost Accountant

Supercar!

(From the Drawing Boards of Sundberg and Ferar)

PLANS for post-war driving call for "supercars" in plastic as suggested by the above conception of outstanding industrial designers.

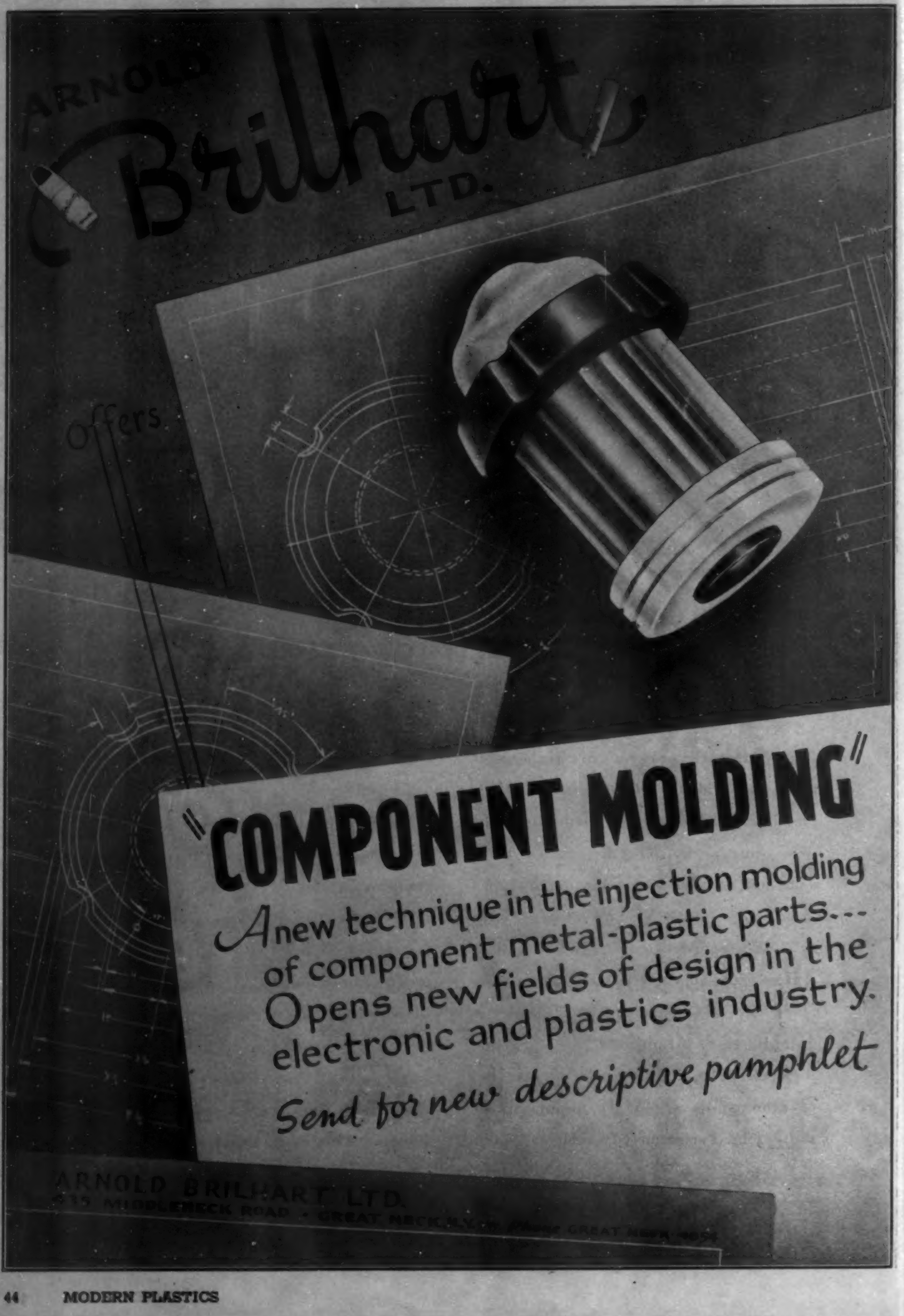
The combination of light weight, strength and moulding-quality of plastics, plus new moulding techniques, make possible this streamlined, tear-drop body design. Full-vision plastic windows offer new driving safety and pleasure. Plastic accessories and trim add to beauty and to economy of production.

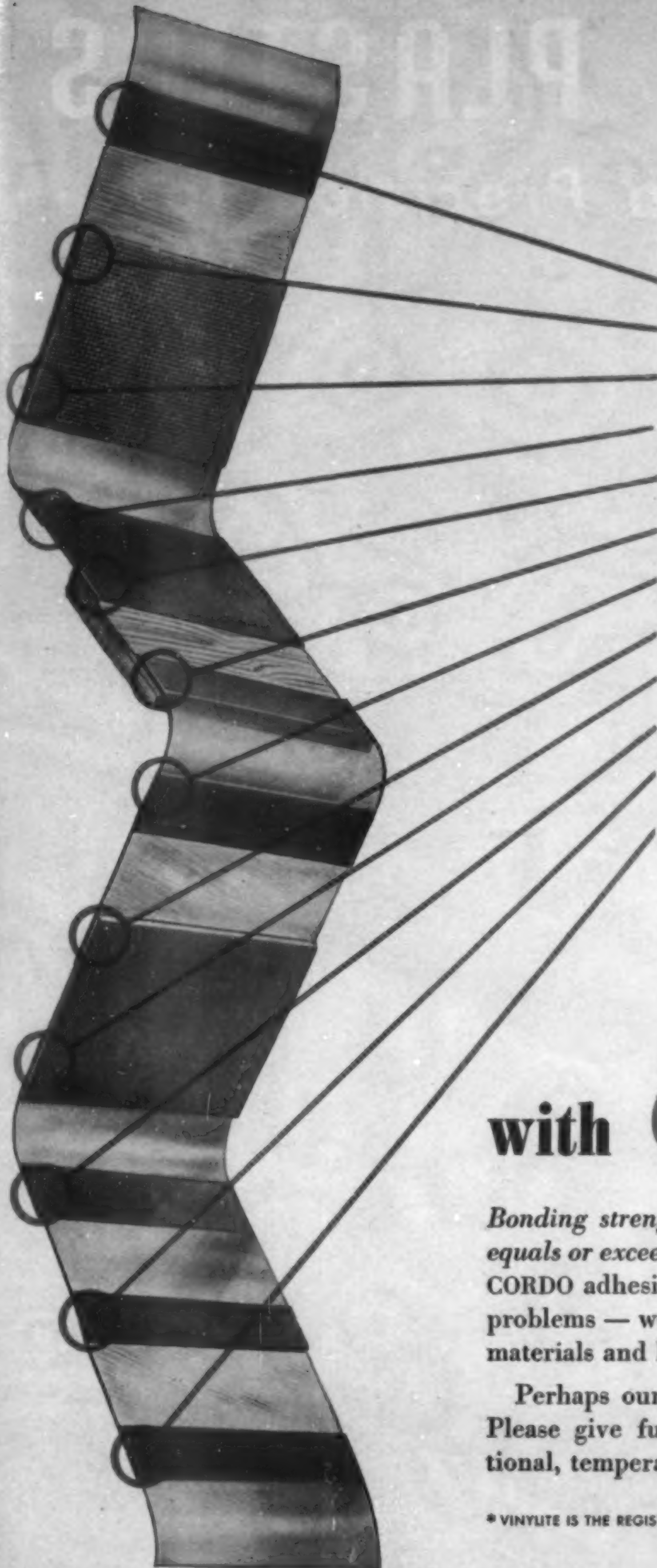
But plastic "supercars" are only one of the many things designers and engineers are thinking of in terms of the future. Planning-ahead in plastics is unrestricted. *In every field* of industrial and consumer application, plastics are being seriously considered for tomorrow. To help you plan your products for the future, call upon the well rounded experience of Kurz-Kasch craftsmen . . . plastic engineers, toolmakers and moulders . . . specialists in plastic design and production for more than a generation.

KURZ-KASCH

Planners and Molders for the Age of Plastics

Kurz-Kasch, Inc., 1417 South Broadway, Dayton, Ohio
Branch Sales Offices: New York • Chicago • Detroit • Los Angeles • Dallas • St. Louis • Toronto, Canada. Export Offices: 89 Broad St., New York City


ARNOLD
Brilhart
LTD.
Offers
"COMPONENT MOLDING"
A new technique in the injection molding of component metal-plastic parts.-- Opens new fields of design in the electronic and plastics industry.
Send for new descriptive pamphlet
ARNOLD BRILHART LTD.



All Perfect Bonds with CORDO Adhesives

Bonding strength approaches, and, in some combinations, equals or exceeds the strength of the materials being bonded. CORDO adhesives were developed to meet specific bonding problems — working closely with the manufacturer, his materials and his methods.

Perhaps our research laboratory can be of help to you. Please give full details of your bonding problem, operational, temperature and pressure facilities.

* VINYLITE IS THE REGISTERED TRADE MARK OF CARBIDE AND CARBON CHEMICALS CORPORATION

CORROSION CONTROL CORPORATION
(AFTER JANUARY 1, 1944—CORDO CHEMICAL CORPORATION)
34 Smith Street, Norwalk, Connecticut

INDUSTRIAL COATINGS • FINISHES • LACQUERS • ADHESIVES

CORDO

MODERN PLASTICS

for a Precision Tool . . . .

. . . that Provides a MODERN Method of Checking Micrometers and Other Precision Inspection Devices

Sav-Way's new set of Master Setting and Checking Rolls is housed as befits a precision tool of this calibre, in a modern transparent plastic case.

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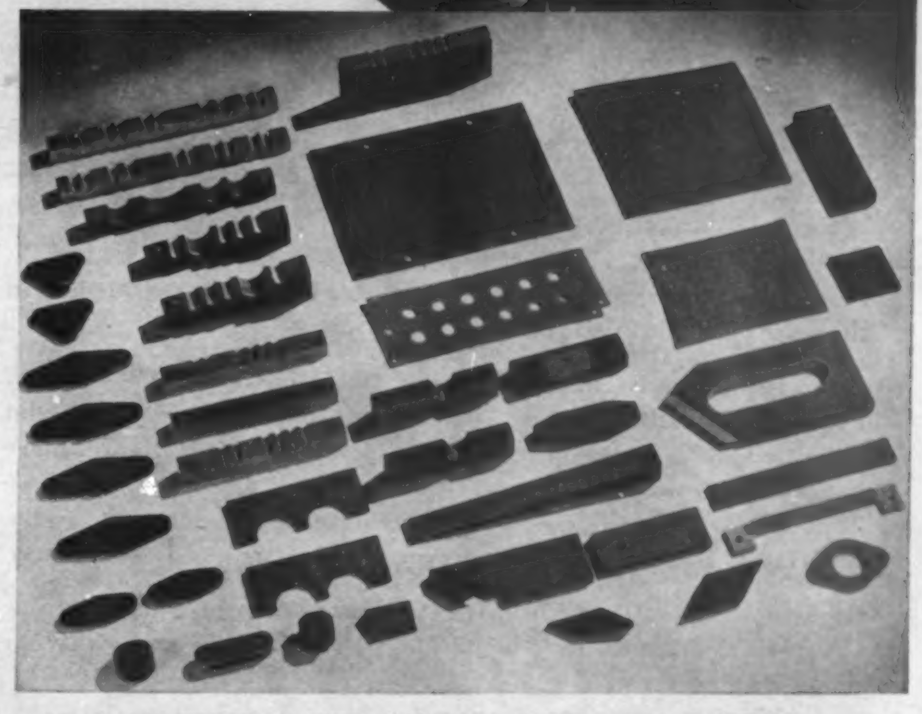

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An interesting application concerns a washer used in electrolytic and oil type condensers. The washer is placed on the end of tin can electrolytic condensers with the Synthane face exposed to the chemicals to prevent deterioration. The can is crimped into the rubber to make a tight seal.

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Combinations of rubber and Synthane have been furnished with rubber on one side, Synthane on the other; rubber on both sides with Synthane between; Synthane on both sides and rubber between; and alternate laminations of rubber and Synthane built up to any desired thickness.

There are many more possible uses for Synthane-rubber sandwich materials, which we cannot describe because of military censorship. There are also many important uses for a combination of Synthane and Neoprene.

Synthane-Synthane

Occasionally two grades of Synthane are combined. For instance, in certain radio tube sockets, layers of fabric

and paper base Synthane are combined. The paper base has usually better electrical properties while the fabric base furnishes added strength where the stress is greatest.

Bobbin heads in the textile industry are often made of paper and fabric base combined. The fabric base endures rough handling, whereas the paper base on the inside of the head provides a smooth wearing surface.

Synthane-Asbestos

Synthane is wound about asbestos (or fibre) tubes and cured in the manufacture of tubing for large fuse cases. Synthane adds strength and rigidity to the fire resistance of the asbestos or fibre.

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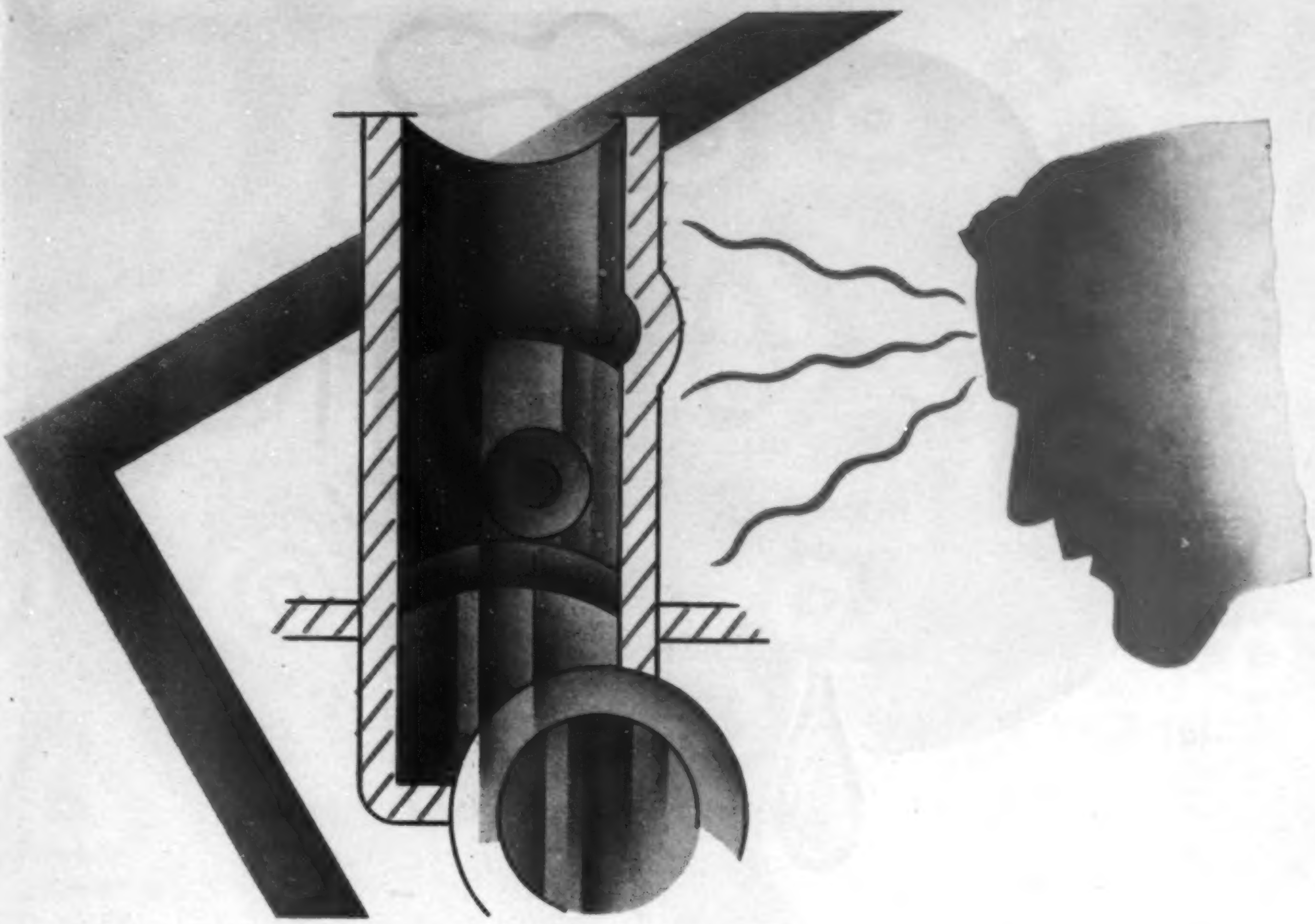

E N G I N E E R I N G

In planning and developing products destined for postwar markets, it is axiomatic that they be *engineered* from the basic conception to the finished product. Whether your particular product should be molded complete of plastics or include plastic parts in its production is a problem for engineers who know plastics thoroughly...know their limitations as well as their possibilities. Our organization includes engineers who are trained in working out design problems from our customers' viewpoint. Their recommendations are based on sound engineering practice and are offered only after a careful study of all phases of your problem.

The services of our Planning Division are available to any company considering the use of molded plastics in its postwar manufacturing plans. A request for consultation involves no obligation on your part.

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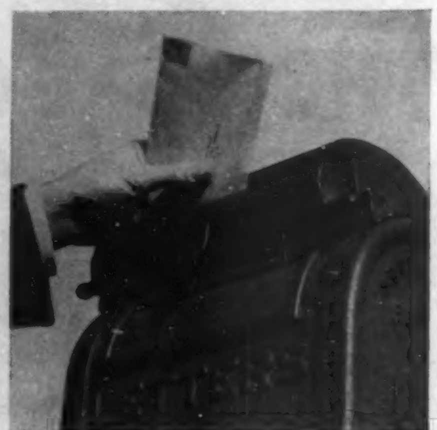

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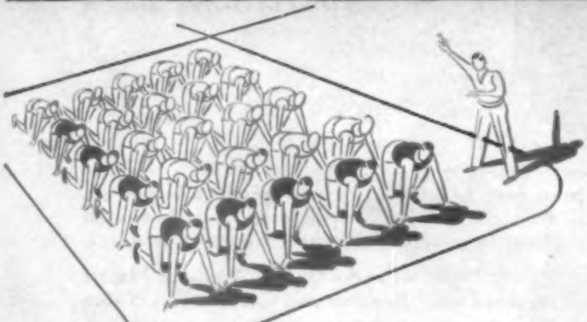

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MODERN PLASTICS

DECEMBER, 1943 VOLUME 21 NUMBER 4

1

2

1—Front view of binocular carrying case molded of phenolic and plasticized vinyl material, showing the strap fastening of the cover. 2—A wide strap attached to the cover and case at the back, serves as a hinge

Carrying cases for binoculars*

by LT. W. R. BAILEY†

OPTICAL instruments are necessary adjuncts to the successful performance of present-day military equipment. Without them, guns, tanks and ships as well as other weapons of war operate at a disadvantage. Of the various instruments of this type now used by the Armed Forces, binoculars have by far the greatest general utility value. Because of their importance it is essential that these instruments be carefully safeguarded against injury.

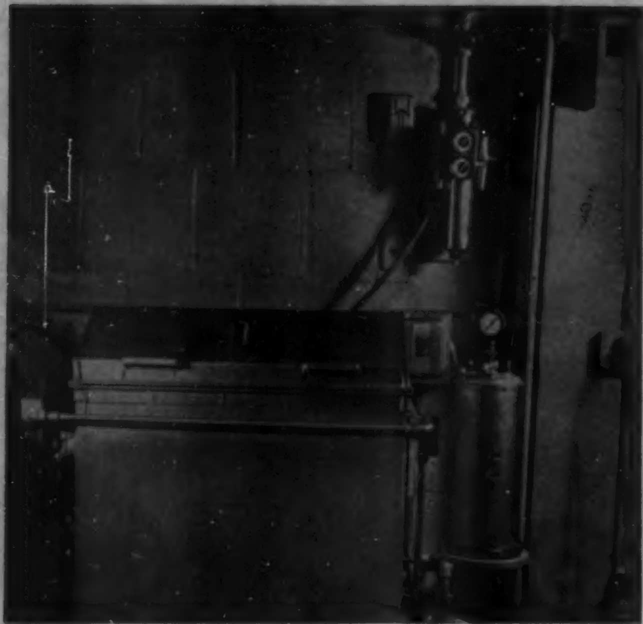
Since the development of poro-prism type binoculars less than 75 years ago, binocular carrying cases have been fabricated from either leather or canvas. Canvas deteriorates and rots very rapidly under normal service conditions. Leather, the most satisfactory material for the purpose, has definite disadvantages. When exposed to salt air and moisture over long periods of time, it crazes, cracks and deteriorates. Warpage occurs when leather is subjected to temperature and humidity extremes, and the cases cannot be maintained in a moisture-tight condition. Leather also has the characteristic of promoting bacterial and fungi growth, with resulting mold on the surfaces of the material under humid weather conditions.

With these factors in mind and with leather becoming increasingly scarce Commander T. O. Brandon of the Naval Observatory recommended to the Joint Optics Committee of the Army and Navy Munitions Board in the spring of 1942 that a binocular carrying case be fabricated from a suitable plastic material as a replacement for the leather case then in use. Several meetings were held on this subject at the Naval Observatory, and many companies participated in submitting plastic materials for tests. Since these cases had to withstand severe weather conditions and rough treatment, it was necessary for the Naval Observatory to properly evaluate the materials under consideration. The test procedures to which these plastic materials were subjected are described in order to emphasize the stringent requirements that had to be met.

The materials first were subjected to a 240-hr. accelerated weathering test. These samples underwent a light radiation and fog cycle for the purpose of determining the relative resistance of the materials when exposed to weathering. This test is similar to the accelerated weathering test described in Federal Specification L-P-406, paragraph B-14, except that the specimens were exposed 7 in. below the bulb. Then the materials were subjected to a continuous salt spray cycle (Fig. 3) for a period of 100 hr. at a temperature of 94° F. to determine the corrosive effect of salt air upon the metallic rivets under extreme simulated service conditions. This test is described in A.S.T.M. Method D117-41 T.

Since strength and resiliency are important characteristics of a satisfactory carrying case, impact tests at a temperature of −50° F. were made on the plastic materials. The specimens were clamped on a solid base and $^{1}/_{4}$-lb. steel ball, $1^{1}/_{4}$ in. in diameter and mounted in a bell dropping tube, was

* Presented at the Fall Meeting of the Society of the Plastics Industry in New York on November 8.
† Materials Laboratory, Naval Observatory, Navy Department.



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3—Equipment used for salt spray test. 4—Both binoculars and carrying case are impact tested on this apparatus. 5—When measuring abrasive resistance, specimens are mounted on vertical wheel rotating at 30 r.p.m. on a disk covered with a silicon-carbide abrasive paper

raised 4 ft. and allowed to fall on the materials (Fig. 4). The samples were subjected to a 7-day cycle of temperatures, ranging from −10 to +160° F. with relative humidities ranging from 0 to 100 percent. This test was designed to evaluate the relative resistance of materials to warpage and shrinkage thereby predetermining the dimensional stability of the plastics.

Since flexibility is a necessity in binocular carrying cases, the materials underwent a flexural resistance test. This consisted of bending the materials to $^1/_2$-in. radial curvatures over temperature ranges from 0 to −50° F. in order to determine the embrittlement of the material. The materials also were tested for abrasion resistance, using the Taber Abraser and the National Bureau of Standards Sole Leather testing equipment (Fig. 5). These tests consisted of determining the loss of weight of the samples in 1000 revolutions of an abrasive wheel against their surfaces.

Eight types of materials were presented for consideration—stitched plasticized vinyl reinforced with fiber board, laminated and formed plasticized vinyl reinforced with rigid vinyl sheet, molded ethyl cellulose, laminated and formed fabric impregnated with cellulose acetate butyrate, molded cellulose acetate, lacquered and stitched pressed fiber impregnated with latex, stitched leather reinforced with fibre board and fabric, and laminated and molded plasticized vinyl reinforced with phenolic-impregnated fabric. The results of the tests are presented in Table I. Phenolic and plasticized vinyl material was found to most satisfactorily meet the requirements.

A New England molding plant collaborated with the Naval Observatory in adapting this material to the case design. Several preliminary sample cases were made and subjected to tests, and in Aug. 1943 the first completely embossed finished case was examined and tested by the Naval Observatory and found to be satisfactory for Navy use. A slight fading of the carrying case occurred when subjected to the accelerated weathering test. The variation amounted to 0.5 of a Munsell color step. Only very slight warpage was noted in both

the case and cover. The plastic material satisfactorily withstood the salt spray test, but the rivet heads and snap fasteners corroded slightly. The impact resistance test indicated no breaking or cracking of the interior or exterior surfaces. The top of the sample case molded of the same vinyl-phenolic plastic as the body, showed very slight warpage when examined after the accelerated warp test. When subjected to the plastic flexural resistance test, the material commenced to become semi-rigid at $-20°$ F. but remained sufficiently flexible to be serviceable to $-50°$ F. The plastic material was found to have an average Taber abrasion index of 10 milligrams indicating its superior abrasion resistance when compared to the average grade of leather which is 60 milligrams loss per 100 revolutions.

Inspection of the case subsequent to completion of the testing cycle indicated no separation of laminations or other deleterious effects. The sample binocular case and cover straps weigh the same as a leather binocular carrying case of the the corresponding size. The results of simulated service conditions tests indicated that the subject binocular carrying case has sufficient resiliency, flexibility, dimensional stability, rigidity and weather resistance for satisfactory performance under actual service conditions. The seamless molded construction, watertight cover seal and the moisture resistant plastic material results in a waterproof carrying case.

In view of the superior characteristics, it was recommended that this plastic case, molded from a fabric containing phenolic, laminated and sealed with a vinyl plastic of high molecular weight type, replace leather as the Navy standard binocular carrying case. Samples of the new plastic case were requested by the Army Chief of Ordnance. These binocular cases were inspected at the Frankford Arsenal and found to satisfactorily meet all of the Army requirements.

A comparison of this newly developed plastic case with the one made of leather is of interest. Binocular carrying cases fabricated from the special vinyl-phenolic formulation, as covered in patents filed as Navy Case 3436, have been found to be more serviceable than leather cases. Abrasion and scuff resistance is approximately 6 times greater than that of average grade leather. The plastic cases are not affected by exposure to weathering, while very rapid deterioration occurs in leather. The surfaces of the plastic cases will not mar, nor will the color rub off and stain clothing as do the surfaces of leather cases. The resilient thermoplastic surfaces of the cases provide an excellent exterior gripping surface while the interior surfaces are sufficiently soft to preclude injury to the binoculars.

Although flexibility and elasticity are retained by the plastic cases in both arctic and tropic temperatures, the material contains sufficient reinforcement to afford adequate protection for the binoculars. The structural reinforcement of the cases maintains dimensional stability characteristics under all humidity and temperature conditions. The moisture resistant material provides for waterproofing, and it is unaffected by either mold or fungi growth. The molded fabric-reinforced plastic carrying case exhibits greater strength and durability than similar straps fabricated from leather. Unlike most resilient plastic materials, the surface of this case will not oxidize, craze, crack, exude, soften or deteriorate when subjected to petroleum fractions, body acids and exposure to salt water for long periods. The plastic carrying case is readily adaptable to mass production since the type of plastic materials from which the case is fabricated can be molded and embossed in a single operation.

Acknowledgment

Appreciation is expressed for the participation of the National Bureau of Standards, the Society of the Plastics Industry and many companies in this development work. The following companies, among others, gave much of their valuable knowledge and time: Bolts Co., Carbide and Carbon Chemicals Corp., Dow Chemical Co., E. I. du Pont de Nemours & Co., Inc., Gemloid Corp., Hood Rubber Co., Plaskon Co., Tennessee Eastman Corp.

Special commendation should go to the Hood Rubber Co. which made available for this project their entire experimental and development facilities. It is through their close cooperation that this case has been adapted to mass production.

TABLE I.—EVALUATION OF VARIOUS TYPES OF CARRYING CASE MATERIALS

Test	*Laminated and molded plasticized vinyl reinforced with phenolic-impregnated fabric*	*Stitched plasticized vinyl reinforced with fiber board*	*Laminated and formed plasticized vinyl reinforced with rigid vinyl sheet*	*Molded ethyl cellulose*	*Laminated and fabric impregnated with formed cellulose acetate butyrate*	*Molded cellulose acetate*	*Lacquered and stitched latex-impregnated pressed fiber*	*Stitched leather reinforced with fiber board and fabric*
Accelerated weathering (240-hr. test No. 4)	Good	Good	Fair (deformed)	Fair (slight crazing)	Good	Fair (crazing)	Fair (crazing)	Fair (dulling)
Salt Spray (100-hr. test No. 5)	Good	Good	Good	Good	Good	Good	Fair (soggy)	Fair (dye runs)
Impact Resistance (4 ft., $-50°$ F., test No. 7)	Good	Good	Good	Good	Good	Bad (shattered $-20°$ F. at 24 in.)	Good	Good
Accelerated warp (7 days, 160 to $-10°$ F., test No. 9)	Good	Good	Bad (distortion and shrinkage)	Good	Good	Fair (distortion)	Fair (soggy)	Fair (shrinkage)
Flexural resistance ($1^1/_2$-in. radial bend, test No. 11)	Good	Fair (hinge broke)	Bad (too rigid; hinge broke)	Good	Fair (too rigid)	Fair (too rigid)	Good	Good
Abrasion resistance	Good	Good	Good	Fair	Fair	Fair	Bad	Fair
Construction	Good	Bad (too heavy)	Fair (too heavy)	Good	Fair (heavy seams)	Good	Fair (fungi)	Fair (fungi)

A new polystyrene plumbing fixture

by E. F. LOUGEE*

IT SEEMS that plastics are headed straight for the bathroom where they will take over some of the chores performed by metals before the war. Not long ago, readers of this magazine were told about a new all-plastic direct flush valve for toilets of the type usually found in hotels and in some of the more modern homes. But that leaves between 30 and 40 million of the "gurgling reservoir" type toilets in which the brass and copper parts are wearing out with very few replacements left in stock.

The necessity for replacements has been accentuated by conditions in war production areas where three shifts of workers operate in factories around the clock and thousands of families have doubled up or rented spare rooms until toilet equipment is taxed beyond its normal use and is wearing out with alarming speed. The danger of this situation was recognized more than a year ago, and designers were set to work on a plastic ballcock replacement unit which would be ready when the bottom of the brass stockpile was reached. That moment now is close at hand and tests indicate that the plastics ballcock is an improvement over the brass device.

So that there will be no misunderstanding of the subject under discussion it may be well to point out the main difference between a direct flush valve and a ballcock mechanism. The direct flush valve permits a measured flow of water under pressure from the main supply pipe to the toilet. The ballcock requires a reservoir which supplies the water, and this reservoir must be refilled and maintained at the proper level after each discharge. A peek under the hood while the device is in operation shows that when the valve is tripped to flush the toilet, the float ball drops as the water flows out. This movement opens a refill or inlet valve which permits fresh water to flow into the tank. The water reaches its normal level in contact with the float ball; it lifts the ball and closes the valve. There are a dozen or more moving parts to get out of order.

* Plastics Institute.

1—The many moving parts in this brass ballcock tend to corrode and gather scale. Each metal part is cast and must be machined, drilled and tapped before assembly. All threads are cut by hand. 2—Simplified in design to reduce the number of moving parts to two, this injection molded polystyrene ballcock valve will not corrode like the brass fixture. The float ball is molded of acetate; the refill tube is extruded, then bent

BEFORE ↓

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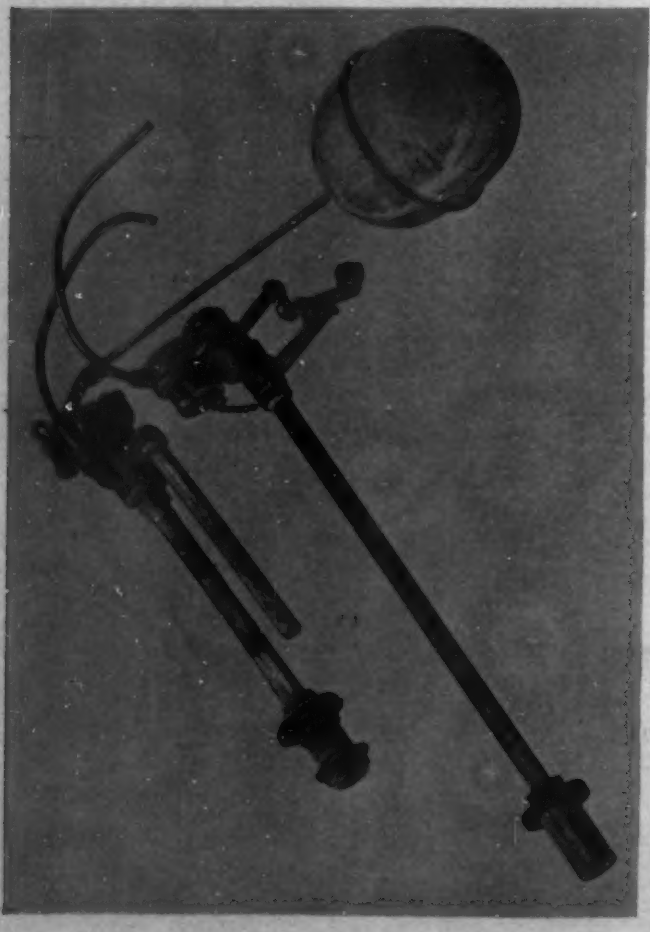

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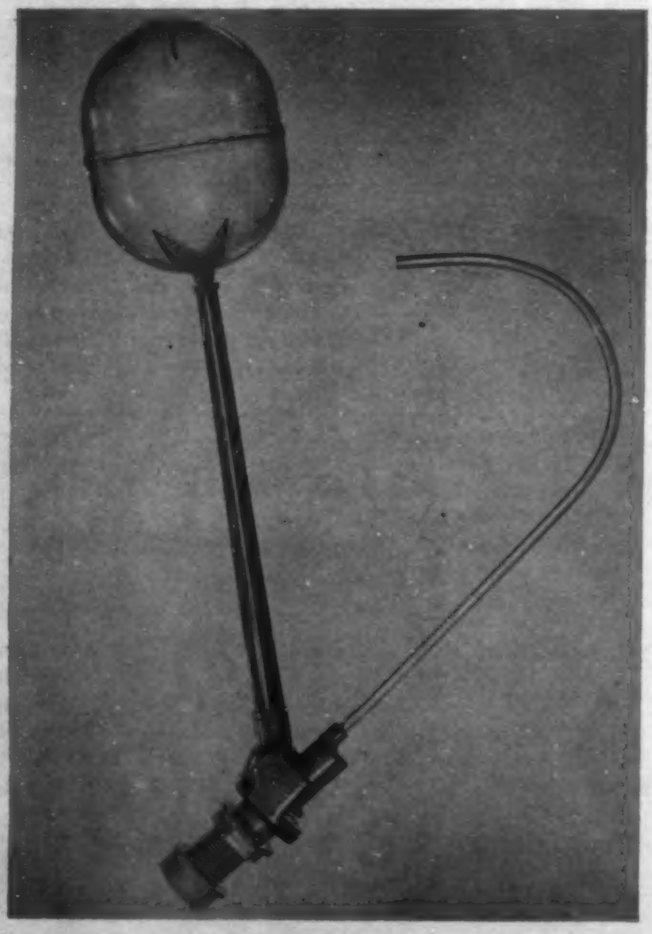

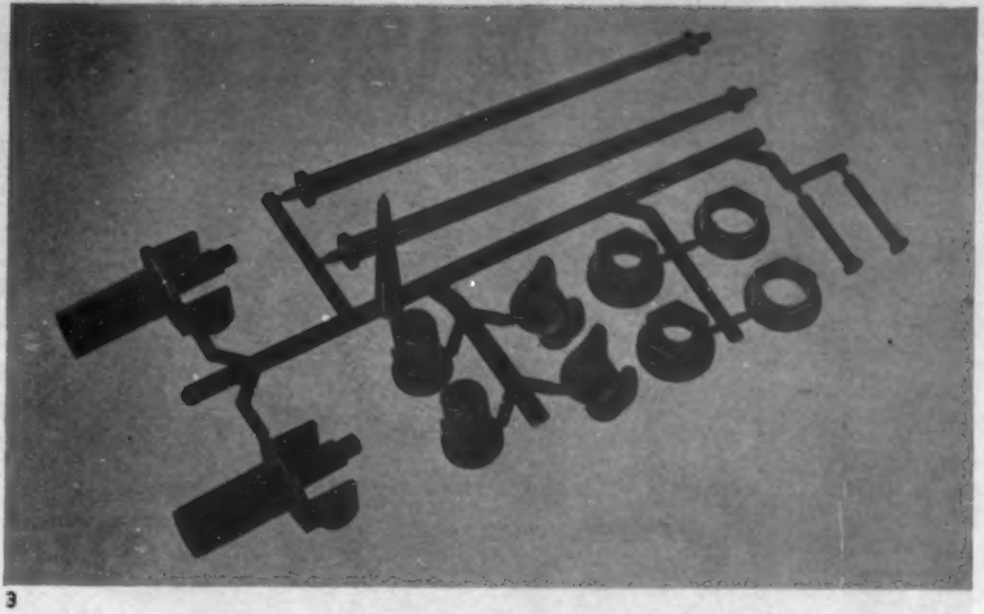

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3—Two complete ballcock units are injected every 32 sec. in a single mold. Threads are molded on main connection and ball-rod ends, but they must be tapped by hand in the assembly nuts. Assembly consists of drilling one hole, inserting pin and screwing parts in place

Until about a year ago the float ball was made in two halves of thin copper. The two metal halves were joined in the center, and the ball tightly sealed to confine the air which insured bouyancy. A slight dent in the thin copper walls or any parting of the seams caused the float to leak—rendering it useless. In some sections of the country chemical action within the water attacked the copper ball, likewise causing leakage. Although cellulose plastics long have been available, it was not until copper was put on the critical list that it occurred to anyone to use them for ballcocks. The plastic float ball also is made in two halves, but it is sealed with acetone which is a solvent of the plastic and makes it impossible for the seam to part. Actually the part becomes a one-piece hollow ball from which air cannot escape, and it is immune to any chemical action within the water. Its walls are thin but flexible, thus eliminating the danger of denting. Considerable force would be required to crush the plastic ball—much more force than is likely to be encountered either in shipment or in service.

The satisfactory performance of the float ball may have been responsible in part for the development in polystyrene of the complete ballcock mechanism. Whatever the reason, this assembly is ready to take up where brass left off. It comes just in time to prevent any breakdown of our sanitation system which might endanger the health of war workers in crowded quarters. Furthermore, its savings in copper, brass and man-hours indicate a trend in modern manufacturing likely to be reflected in other fields.

The conventional ballcock of metal uses approximately 40 oz. of copper and brass. For the plastics version 3.5 oz. of polystyrene are required—a reduction in weight of better than 90 percent. The saving in man-hours for finishing and assembly is in direct proportion. The brass assembly consists of a number of moving parts which vary according to make. Each piece is cast and must be machined, fitted and finished. Assembly holes must be drilled, and where threads are required they must be tapped. The plastics version has seven parts only two of which move as the device works.

As can be seen in Fig. 2 the ballcock consists of: (*1*) the base connection which attaches direct to the supply line and forms the seat for the valve and rocker arm brackets; (*2*) the valve cap which lifts when the float ball drops and opens the valve; (*3*) the rocker arm whose two prongs rest against the flange of the cap to hold it closed when the float ball reaches its highest position in the tank. The rod which supports the float ball screws into the end of the rocker arm; (*4–5*) attachment nuts used on base connection with the main supply line; (*6*) pin which holds rocker arm to base unit and serves as a bearing for the rocker motion; and (*7*) the float ball rod, threaded at both ends.

All seven parts are injection molded, two complete units at a shot on a single sprue (Fig. 3). Threads are molded into the supply pipe, but the two connecting nuts must be tapped for threads. After the rocker arm is assembled on its bracket, one hole is drilled straight through top and bottom to accommodate the plastic pin which holds the part in place. Gates are so thin at the parting lines that no finishing is required on the parts.

While the assembly sounds like a simple one, it involves considerable engineering and planning. To begin with, the plastics ballcock was designed especially for plastics and bears little if any resemblance to the bronze fixture it replaces (Fig. 1). The original hand-made plastics model was put through all sorts of tests. The first plan was to make the unit of phenolics, but WPB pointed out that phenolics are just as scarce as brass. However, in their letter they suggested that "you might use acetate butyrate which apparently is working out satisfactorily for a number of plumbing items." WPB concluded with the encouraging note: "There is a tremendous shortage of ballcocks at the present time and if you can develop one which will effect a saving of brass, your firm will be contributing greatly to the war effort."

On the strength of this statement, work was started on a mold. However, before investing five or six thousand dollars in a die, these engineers wanted to be sure the device had every functional advantage of its predecessor in addition to those inherent in the plastics themselves. The prime requirements were for a valve that would always work under any circumstances; a plastic material that would insure this function as well as save brass; and a fool-proof device that any plumber could install and maintain.

A positive shut-off is essential in the ballcock to prevent water from draining out of the tank into the main supply line in case the source of water is shut off outside the house or building where the tank is installed. Water must be prevented from draining out of the tank into the line where it might be withdrawn through a faucet in some other part of the house. Also, a positive shut-off must be provided to prevent overflow of the tank when the float ball rises to its normal filled position. This task (*Please turn to page 164*)

Shipyard invasion

PHOTO, COURTESY U. S. MARITIME COMMISSION

1—The Pierre S. Du-Pont, Liberty ship, returning from a successful trial run up the river

THREE thousand ships carried Allied power to Sicily and incalculable concentrations are required to provide the "bridge" to the continent of Europe. American shipyards, by a vast production of tonnage (Fig. 1), are making possible this application of overwhelming force, and plastics have been an important factor in the success of the world's greatest and most vital shipbuilding program. In virtually every phase of ship production, from initial design to the voyage overseas, plastics make their necessary contribution.

The marine architect, construction foreman and novice workman all make use of carefully scaled plastic ship models and of plastic templates to pattern ship production (Fig. 2). High-impact phenolics are used to make specialized, high-precision tools. Plastics replace and often improve upon unobtainable critical materials in the big Diesel engines, propeller bearings and other operating equipment. Plastics outfit the ship, preserve a perishable cargo, even carry the captain's message when course or speed must be changed to evade a lurking submarine. The applications of plastics for marine use are too numerous to list, so this article will describe only the newer and more important developments.

Laminates and plywood in ship construction

Wool-glass laminates—One of the largest single advances is the increasing use of laminated phenolics, both for thermal insulation and as the medium for smooth, efficient and economical ship operation. Wool-glass laminates are proving valuable for all types of ship insulation for it has been discovered that heat is conducted through the steel in the hull at a rate more than 1000 times greater than through this insulating plastic. Capable of use at any temperature from sub-zero to 900° F., the wool-glass laminate meets the most important single requirement demanded by the Navy for ship material—noncombustability. This superiority has had much to do with its use in place of cork as insulation. Light weight is another advantage of the wool-glass for it permits increased fire power, cruising radius and speed.

In cargo carriers the wool-glass insulation material is used in great quantities for hull, bulkheads, superstructure and refrigerated areas. Cargo ships used for Lend-Lease shipments and to carry supplies for our armed forces, are equipped with huge ice boxes, and even the spacious holds can be changed readily into refrigerated compartments. In many of these installations wool-glass is used for insulation, with plywood as retaining walls.

In the manufacture of wool-glass laminate, phenol-formaldehyde resin first is sprayed into the glass fibers in quantities varying from 1.5 to 4 percent by weight. The wool is then formed or compressed under heat that sets the resin. For insulating various structural parts and mechanical equipment, the material is applied in blocks, blankets, sheets, ribbons (Fig. 3) or plastic form depending upon the particular requirement. When applied to surface areas, the wool-glass can either be supported with facing or impaled on clips.

For welding the impaling clips to steel plate, use is made of a special stud-welding tool (Fig. 4) which, interestingly enough, is encased in a plastic body. The clips or pins are inserted in the bonded insulation material and their ends welded to the steel wall or ceiling.

The wool-glass material also can be compressed into boards which are suitable for interior finish. These boards of compressed fibers can be cut to desired shapes with an ordinary knife (Fig. 5) and applied to side walls above wainscot and to ceilings as paneling. Used in this bonded form, the finished board itself provides insulation and noise reduction. This permits a considerable saving of metal since in the past insulating material was held in place by sheets of aluminum. Major Hubert D. Keiser, Chief of Cork-Asbestos-Fibrous Glass Section, Materials Branch, Resources and Production Division, in discussing this development before the recent annual meeting of the American Institute of Mining and Metallurgical Engineers, said: "It is estimated that this single improvement saved in 7 months more than 5 million pounds of aluminum."

2

PHOTO NO. 2 & 5, COURTESY MARINSHIP
PHOTO NO. 3, COURTESY OWENS-CORNING FIBERGLAS CORP.
PHOTO NO. 6, COURTESY DOUGLAS FIR PLYWOOD ASSOC.

Plywood panels and insulation—Plastic-plywood is another material steadily growing in importance and volume to meet wartime need for shipping tonnage. As much as 10,000 sq. ft. of plywood go into a 10,500-ton Liberty ship built in the Kaiser yards (Fig. 6). Not all of this material goes into wheelhouse, cabins and bulkhead paneling. One of the largest uses is for insulation of ice boxes and other refrigerated compartments. In a typical installation, the walls of a refrigerated space are lined with 1/4-in. thick plywood panels retaining a 3-in. layer of insulating material. The waterproof quality of plywood makes it particularly suitable for this use. Recently plywood has been substituted for regular wood flooring in refrigerators. In one such application employing 5-ply plywood, tests showed that there was only a 3° F. loss of temperature after refrigeration was shut off for 24 hr., compared to a temperature loss of 15° F. under similar conditions with an ordinary wood floor.

Laminated bearings—Plastics also play an important part in the operating equipment of ships. Cloth impregnated with phenol-formaldehyde resin to form a tough, hard-wearing laminate now is used extensively for propeller shaft bearings, rudder bearings, pintle bushings and other similar applications. Actual operating experience has demonstrated the advantages of this material.

Comparative operating tests of laminated phenolic stern tube bearings (Fig. 7) and those made from lignum vitae have shown the superiority of the plastic parts in wear, weight, water absorption and replacement cost. The tests show that the plastic bearings wear 3 times longer than those made of wood. The resin bonded composition bearings installed on one ship showed only .045 in. wear with no appreciable wear

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2—Templates such as these being assembled in a shipyard mold loft can be made entirely of plywood, or plywood can be used to reinforce the wooden frames. 3—Wool-glass laminate in ribbon form is used for ship pipe insulation. 4—This stud-welding tool has a plastic body. It is used to weld the clips that hold wool glass to the steel plates. 5—Wool-glass material compressed into boards can be cut to desired shapes with an ordinary knife. 6—Plywood in panels varying from 1/4 to 1 in. in thickness is used to line this officers' mess and all other rooms above deck on our Liberty ships

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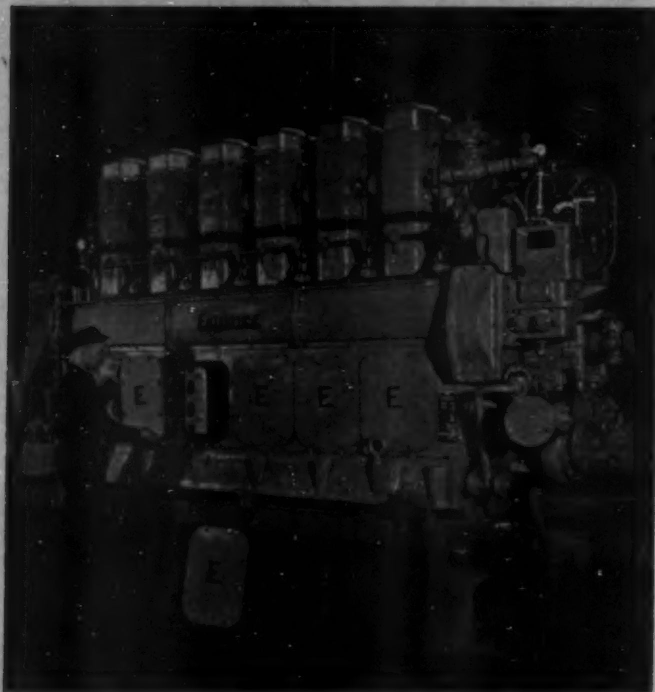

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on the shaft liner, after approximately 70,000 miles travel while the lignum vitae bearing, used under precisely the same conditions and length of travel, showed $^3/_8$-in. wear with the shaft liner worn up to $^3/_{16}$ inch.

The laminated material weighs even less than aluminum—half as much as aluminum of equal strength. Its average density is only .05 lb. per cubic inch.

To test water absorption, a laminated phenolic stern tube bearing was immersed in water for 144 hr. and a similar test conducted with lignum vitae. During the first 48 hr. the phenolic laminate changed only .0065 in. per in. of bearing thickness and there was no further swelling during the 144-hr. test. On the other hand, lignum vitae continued to swell throughout the test, increasing .047 in. per in. after 144 hr. in water.

From the standpoint of production costs, use of plastic material as stern tube bearings possesses definite advantages. First, installation time has been reduced at least 50 percent. The staves now used for solid-pack stern tube bearings are cut to size at the factory, fitting tightly against the smooth-bored housing. Replacement cost also is reduced as spare staves can be stored dry aboard ship without danger of splitting, cracking, warping or other deterioration. The worn staves are easily removed for replacement. All that is necessary is to knock out one stave length and the entire half bearing comes out.

The first step in installing a phenolic laminated bearing is to bore out the bearing shell. Next, two keeper strips are screwed to the bushing wall. The function of these strips is

7—These stern tube bearing staves of laminated phenolic show very little wear after 4 years in service. 8—*Plastic side covers for the crankcase are used on this Diesel engine. The plastic instrument panel, identification and instruction plates can be seen at right.* 9—*Laminations of plywood and hardboard can be seen in this engine side cover which has the insignia molded from cellulose acetate.* 10—*These metal bushings being inserted in a crankcase cover, limit crushing action of cap screws*

PHOTO NO. 7, COURTESY WESTINGHOUSE ELECTRIC & MFG. CO.
PHOTO NO. 8, COURTESY ENTERPRISE ENGINE & FOUNDRY CO.
PHOTO NO. 9 & 10, COURTESY F. L. MITCHELL

10

to lock the staves in position. Third, the laminated staves are placed in each half section of the shell. No machining or fitting is required except for one stave in each section which is shaped to the width necessary for a snug fit. When the 2 final staves, one for each section, are driven in position, the entire bearing assembly is completed. It then is necessary to bore the complete bearing to shaft diameter plus clearance. Each stave used in the bearing assembly is accurately machined from plate material with the layers or laminations running edgewise or perpendicular to the shaft liner, thereby increasing strength of the bearing surface.

Now well past the blueprint stage is a complete bearing assembly in which laminated phenolic material is employed not only for the bearing surface but for keeper strips and liner, heretofore made of bronze. In such small craft as tank landing barges, pick-up boats and rescue vessels, frequently the entire drive shaft is made of plastic, replacing bronze and rubber. These laminated phenolic drive shafts have proved to be highly practical from the standpoints of strength, long life and light weight. On mine sweepers, fair-water caps for propeller blades are made of this material, again replacing bronze. Still another use of this laminated plastic is to replace bronze in the threaded stems which operate shiphold vent valves.

Communication pulleys—Mine sweepers and similar naval craft are outfitted with mechanical telegraph systems for relaying orders from the bridge to engine room. Plastic pulleys now are used to operate these systems, a relatively new application. On a small naval (*Please turn to page 160*)

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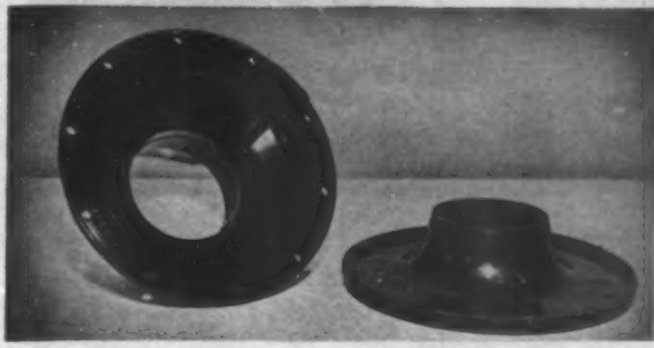

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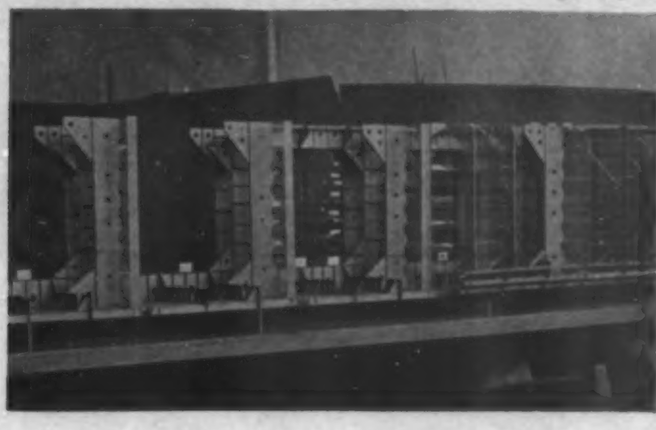

11—This air mover must be tipped as shown, to permit the foul air to be sucked up from the bell-shaped opening in the plastic base and forced out through the horn-shaped outlet. 12—The housing of the blower consists of a plastic base and flange. 13—Scale models similar to this section of a tanker are used for construction and training purposes. 14—Sheets of cellulose acetate are used to represent steel walls in this progress model. 15—Laminated phenol-formaldehyde instrument-board panel

PHOTOS NO. 13 & 14, COURTESY MARINSHIP
PHOTO NO. 15, COURTESY ENTERPRISE ENGINE & FOUNDRY CO.

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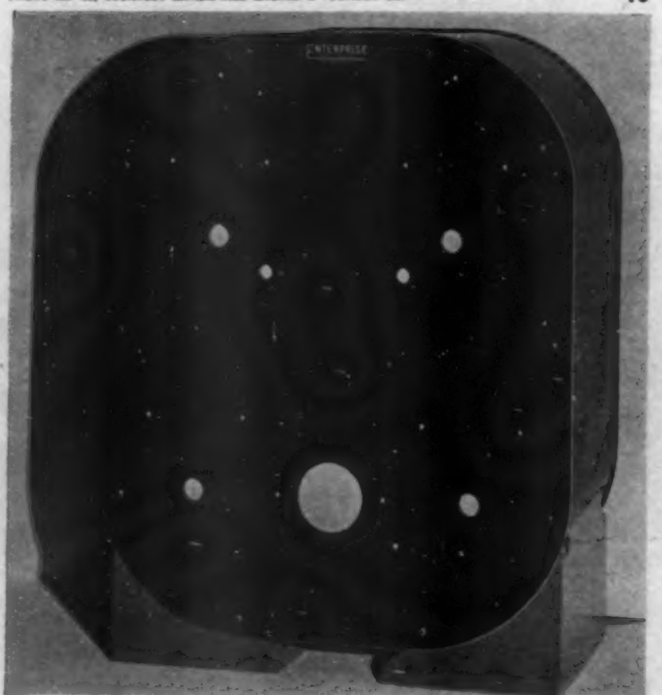
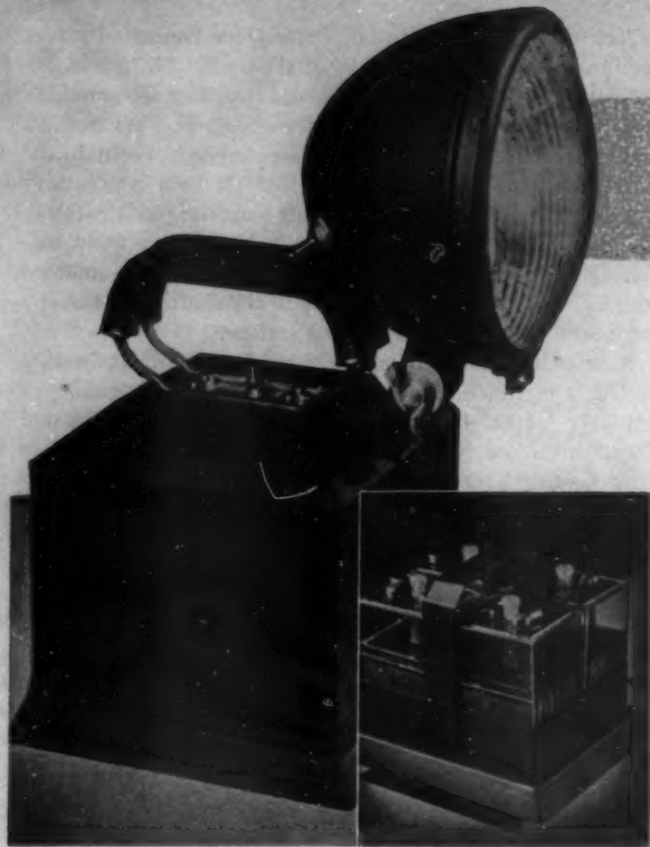




Fool-proof fingerprinting

Fingerprints left on record with the proper authorities must be sharp and clear if they are to serve their purpose of easy identification. In the past, using the usual ink pad method, such prints often were impossible to obtain from persons crippled with arthritis or rheumatism, from the deceased and from babies. The majority of these failures stemmed from the inability of the operator to manipulate the subject's fingers in the proper manner.

The new fingerprinting process, demonstrated by an operator in the accompanying photographs, overcomes this difficulty by transferring the subject's whorls to the operator's finger for printing. Fingers are dipped into a chalky white mixture of rubber or latex and a volatile solvent (top). Solidifying quickly, this coating while changing from chalky white to a light yellow color shrinks so as to adhere firmly to the whorls of the finger. This cap next is slit down the back and peeled off the finger (center). Before slipping the cap onto his finger preparatory to inking, the operator reverses the coating so that the impressions of the fingerprints are on the outside.

As a final operation (bottom illustration) the inked prints are transferred by the usual rolling method to a sheet of transparent cellulose acetate, frosted on one side for better ink reception. In order to observe the whorls of the fingerprints as they appear on the finger, it is only necessary to reverse the transparent sheet. Photographic copies may be obtained by making a direct print from the acetate film or, in cases where reproduction onto a standard fingerprint record card is desired, by photographing through the acetate sheet for exposure onto the record card.

Credits—Material: Fibestos for sheeting. Process developed by Curry Fingerprint Powder Co.

Portable searchlight

In a war of movement one criterion of the value of military equipment is its mobility. Whether the part in question is a tank, a plane or a searchlight, the ease with which it can move or be transported is often an all-decisive factor in its adoption by our Armed forces. This is particularly true of those equipment items that are applicable to a variety of services either on the land, on the sea or in the air.

Weighing but $12\frac{1}{2}$ lb., this searchlight with a strength of 110,000 beam candle-power, comes well within the requirements. Both the Army and Navy use the signalling model for communication in sunlight. The standard light has found its most valuable application on emergency crash trucks and fire fighting apparatus, and in connection with guard duty at arsenals, industrial plants, camps and shipyards. Flying fields use these searchlights to pick up planes 2400 and 3000 ft. above the ground, and tests have established the fact that under certain atmospheric conditions the light can be seen 8 miles at sea—a limitation fixed by the horizon.

Contributing to the lightweight and efficiency of this unit are the four transparent battery cells made of cellulose nitrate. In addition to weighing a third less than the hard rubber cases they replace, these transparent cells make it possible for the operator to check the condition of the battery and the electrolyte level in each cell. Acid resistant and a non-conductor, these cellulose nitrate battery housings have been found under test to withstand a 12-foot drop on concrete. The plastic material also inhibits creepage of the electrolyte and the collection of aciduous residue on the surface of the battery—conditions often encountered when hard rubber housings are employed.

Credits—Material: Celluloid. Manufactured by Dewar Manufacturing Co.

PRODUCT DEVELOPMENT

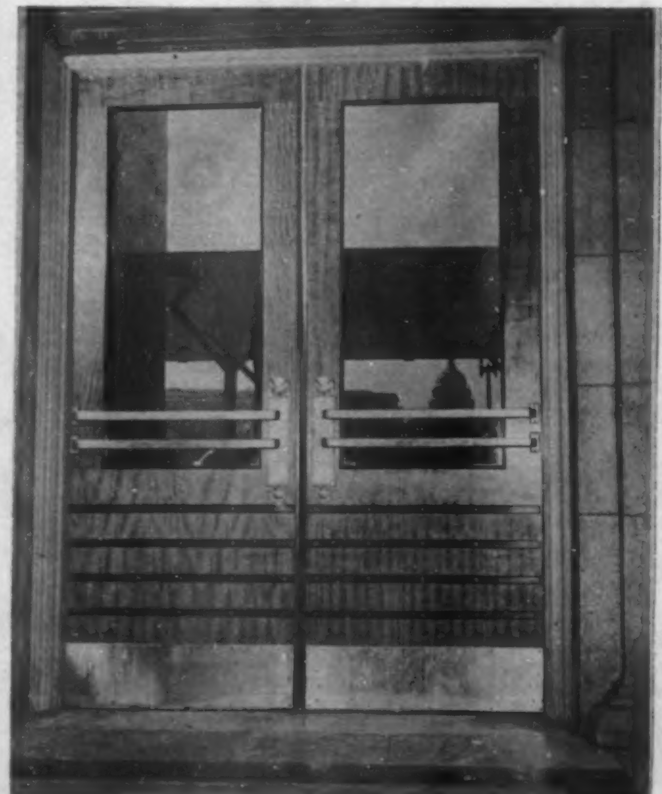
Doors at the Union Terminal

Government workers, industrial leaders, Federal and State officials, military personnel—it is upon people such as these that the doors of the Union Terminal in Washington, D. C., open and close thousands of times each day. And in addition to the people who pass through these swinging doors there is the endless stream of baggage.

Nine banks of 6 doors each take care of this flow of traffic. Each of these 54 exterior doors consists of a laminated lumber core overlayed with $^{1}/_{16}$-in. thick impregnated wood veneers. With a view to the abuse to which these doors are subjected, the swing edge of each was equipped with a molded edge of impregnated wood veneer. As an extra precaution against the hard knocks caused by the hand baggage and trucks which pass through each of these entrances, bumper strips and kick plates of solid black laminated material are provided. These not only tend to save the surfaces of the doors but add much to their beauty.

So successful has been the performance of these doors since their installation that officials of the Terminal now are contemplating the replacement of all interior wood vestibule entrances with doors exactly like those used on the exterior of the building.

Credits—Material: Doors, Ribbon Mahogany Realwood. Bumper and kick plates, Formica.



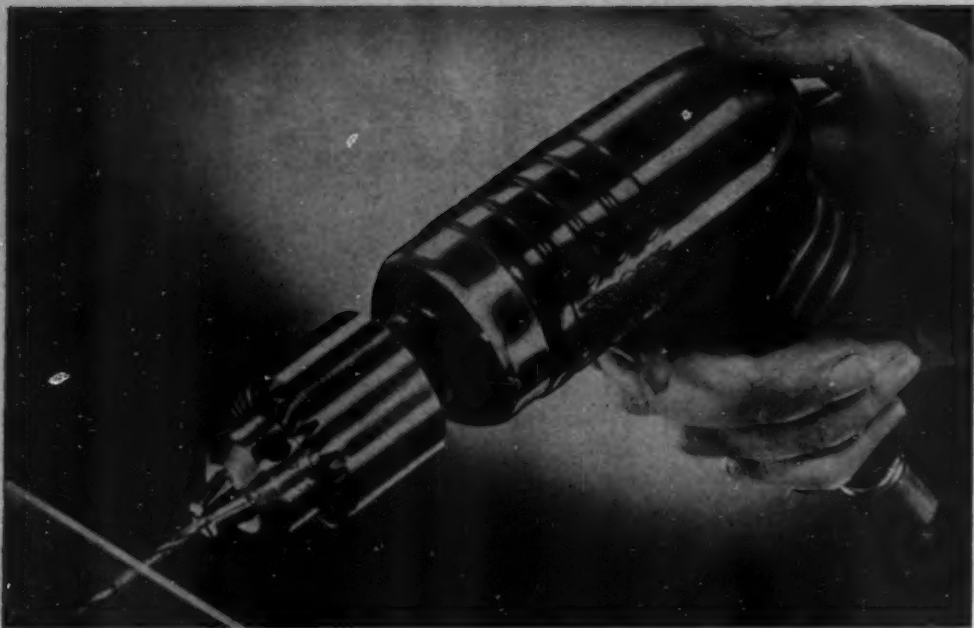
Hose for hydraulic motor

One of the greatest problems in the operation of hydraulic mechanisms is the gumming or clogging of the fine orifices and delicately balanced parts due to attack by hydraulic oils on the inner wall of the hose. This difficulty is overcome in the operation of this variable-speed hydraulic work-drive motor through use of compar-lined, or compounded polyvinyl alcohol resin-lined hose which is not subject to errosion and carries pressure up to 1200 p.s.i.

This plastics family group which has properties unlike the original polyvinyl alcohol resins, grew out of the demand by warplane designers for a flexible material to handle the new aviation "super-fuels." In addition to its application in hose, compar also is extruded into tubing for use in laboratory and medical work, molded into washers, gaskets, and diaphragms, and used in gloves, aprons and other protective garments.

After being milled and formed into a thin cohesive film which has not yet completely fused, compar is transformed into finished and semi-finished products by extrusion or molding. It shows a pronounced flexibility, toughness and abrasion resistance. Careful control in each operation in the compounding and fabricating of these materials permits finished products of widely varying, predetermined durometer hardness, resilience, translucence and other qualities.

Credits—Material: Resistoflex compar.



PHOTO, COURTESY ARO EQUIPMENT CORP.

1—The light weight of the plastic housing of this hand drill together with its air-cooled design is helping to keep production lines moving

One-piece housing for pneumatic drill

ROUND-the-clock production calls for tools that are light and easy to operate and, therefore, not tiring to the worker. But this lightness of weight must be combined with a sturdy construction that demands little or no maintenance. This compact pneumatic drill with an all-plastic housing and handle fills both of these needs. Weighing but $1^3/_4$ lb., the tool develops over $^1/_4$ hp. and is built for continuous production drilling. The plastic housing is $^3/_4$ lb. lighter than the average aluminum casing, and absorbs shocks and abuse to a greater degree.

In the design of the red cellulose acetate butyrate housing one important fact had to be kept in mind. Not only was it necessary for the unit to withstand abnormal handling, but it had to be completely airtight and free from leaks under fairly high pneumatic pressure. This latter qualification was necessary inasmuch as the housing acts as an actual part of the motor in addition to its function as a protective case and hand grip.

Because of the possibility of air leakage, the manufacturer rejected the ideal of molding the grip in two halves and subsequently cementing the parts together. A mold was engineered which permitted the housing to be molded in one piece. Removable cores were needed to hollow out both the handle section and the motor casing. Three air exhaust holes, molded in one side of the housing which supports the motor, insure a constant flow of air to cool the tool when it is in operation. The slot for the trigger also is molded-in. The modeling of the core for the two holes at the base of the handle presented difficulties. These holes which carry threaded inserts are for the oil plug and the air hose connection, and they must be absoutely tight and free of any leakage. It would appear from inspecting the parts that the only finishing operations are the removal of the split line and gate and the final polishing of the parts.

Particular attention should be called to what amounts to an innovation in small hand tools—or in large tools of this type. Transparent plastic disks are inserted in the handle end of this unit. These molded disks serve as "windows" through which the operator can see when the tool needs lubrication. But these inspection ports are only part of this ingenious method of lubrication. By the use of a built-up pressure within the oil chamber of the handle, a small amount of oil is forced into the air passage between the valve and the motor each time the trigger is released. Due to the difficulty of air and oil leakage, dimensional limits are extremely close. The molder states that he has molded this handle to closer tolerances than any other item of production that his company has undertaken.

Credits—Material: Tenite II. Molded by Reynolds Spring Co., for Aro Equipment Corp.

2

2—Since the housing of this drill acts as an integral part of the motor, it was necessary to design the case so that it was absolutely air-tight. This result was achieved by molding housing and grip in one piece

Fall Conference

SOCIETY of the PLASTICS INDUSTRY

GEORGE L. SCRIBNER
PRESIDENT, S. P. I.

IN THE largest and perhaps most enthusiastic meeting in its history, the Society of the Plastics Industry at its Fall Plastics Conference held at the Waldorf-Astoria Hotel in New York City, on Monday and Tuesday, Nov. 8 and 9, gave articulate notice to the world that it had come of age. The 1100 members who were present showed an awareness of their responsibilities by devoting an entire morning to a careful scrutiny of the immediate future of the plastics industry. Charles C. Livingston of Cruver Manufacturing Co., who is chairman of the committee on Post-war Developments, came forward with a carefully prepared program designed to raise S.P.I. to a status equal to that of any other trade group in the country if its members have the courage and tenacity to follow out the plan. Increased dues, closer cooperation and greater facilities for informing the general public of the real facts about plastics are the keystones of this new program. A digest of his discussion is included in this report of the convention proceedings. The two dinner sessions on Monday and Tuesday night were very well attended. An enthusiastic reception was given Quentin Reynolds who spoke on "Russia Today" and on his experiences with the Armed Forces in Sicily and Italy. Ronald Kennear, chairman of the board of S.P.I., presided at this meeting. George K. Scribner, president, presided at the dinner on Tuesday night at which the Hon. Albert B. Chandler, Senator from Kentucky, was the principal speaker. A complete report of the meetings and digests of the speeches delivered at the four sessions are presented on the following pages. General Chairman C. S. Shoemaker was assisted in the arrangements for this Fall convention by Chris. J. Groos, J. L. Herlands, S. I. Howell, C. S. Lawrence, Herman B. Lermer, E. W. Levien, Sidney Lewis, Alfred C. Manovill, C. W. Marsellus, Bernard Schiller and R. D. Werner.

At the opening session on Monday, Nov. 8, Howard Bunn, vice-president of the Society, presided. He introduced Lt. W. R. Bailey, United States Naval Observatory, who spoke on the "Development of the Plastic Binocular Case." A complete report of this interesting plastic application as described by Lt. Bailey may be found on page 75 of this issue.

Dr. R. P. Dinsmore, vice-president of Goodyear Tire & Rubber Co., was the next speaker on the morning program. He delivered a paper on "Synthetic Rubber," a digest of which is presented on the following pages together with several charts.

Synthetic rubber

Extensive investigation of new resin families in recent years has resulted in the discovery of many materials with considerable extensibility. The rubber shortage caused a careful inspection of all abundant synthetic resins to determine if, and to what extent, they might be used as substitutes for rubber. The result was a blurring of definition of the respective fields of synthetic plastics and synthetic rubbers. In this war period when the rubber industry has been forced to use all available substitutes for natural rubber, we have learned the value of the peculiar combination of properties which natural rubber possesses. Even some properties which were considered undesirable have proved to be almost indispensable for certain applications. Incidentally we have learned that the material which best does the job formerly done by natural rubber, is natural rubber. To me, this means that there is real value in distinguishing between rubbers and plastics, and still greater value in knowing the reasons for the differences.

Consider the distinction between the two extremes—the true plastic on the one hand and the true rubber on the other. In the first case the requirements are ready moldability under pressure (or heat and pressure) and resulting stability of form. The requirements may involve either a thermoplastic or a thermosetting material. On the other hand, the requirements for rubber are first that it be plastic while it is being formed and manipulated and second that, in its final form, it be (among other things) highly extensible and capable of rapid elastic recovery from deformation. Since this latter requirement negatives the condition of plasticity, it presupposes the change of state brought about by vulcanization. If we examine the probable structural formulas for various plastics and rubbers, the chief difference seems to be that the plastics are polymers which tend to have greater width and thickness relative to length, compared to the rubbers which are more attentuated chains. In the plastics there also seems to be a more prevalent tendency to cross linkage of various types. Since these structural formulas are not too well established, they must be accepted with caution. However, they afford us some understanding of a way in which polymers intermediate to plastics and rubbers may exist and exhibit certain properties of each class. If we

knew more about the spatial arrangements of the component groups of the various polymers we might, indeed, expect to predict many of their properties.

While much has been written about the phenomena of rubber vulcanization, unfortunately such writings are chiefly statements of theories, tabulations of properties and confessions of inadequate knowledge. Our knowledge of this important process must remain unsatisfactory until we have fairly complete information regarding the initial structures and the way they are altered when vulcanization takes place. It is safe to say, however, that vulcanization produces certain very definite results. It greatly reduces the influence of temperature. It toughens and strengthens the rubber. Its most remarkable effect is to give a very great increase in rapid elastic recovery from large deformation over a range of temperature.

R. P. DINSMORE

To avoid untenable generalization, it may be well to recall the differences in the effect of vulcanization on natural rubber and balata. Balata is considered to be the *cis* form of the hydrocarbon of which rubber is the *trans* form. Balata in the pure form is hard, horny and highly elastic at normal temperatures. At the boiling point of water, however, it becomes soft and plastic, and it loses its elasticity. Rubber is much softer and becomes plastic at much lower temperatures. When vulcanized, rubber becomes harder and more elastic; balata becomes softer, flexible and, to a great degree, similar to vulcanized rubber. In vulcanized form, both are stable and elastic at fairly high temperatures. Thus, in these 2 well-known cases, vulcanization produces opposite effects with respect to hardness. A common effect seems to be an increased temperature range of form stability and elastic recovery.

The evidence indicates that one feature of rubber vulcanization is the bonding to the polymer of sulfur or other vulcanization agent, probably with some tying together or cross-linking of adjacent polymer chains. Comparison of the vulcanization effects on rubber and balata would at least support the assumption that molecular rearrangement may take place at the same time. In the case of both materials, it is evident that heat stability has been increased in a marked degree. These observations are not important because they throw any light on the mechanism of vulcanization, but because they offer a practical means of comparing rubbers with plastics. A rubber must have initial plasticity and, after vulcanization, high extensibility, rapid elastic recovery and good heat stability. A plastic must have initial moldability and ultimate stability of form. It may have one or more of the properties of vulcanized rubber or may have all to a lesser degree.

By selecting a highly elastic rubber on the one hand and a highly moldable and ultimately highly stable plastic on the other, we may compare the essential properties of any intermediate resin and determine whether it more nearly approaches a rubber or a plastic in properties. If we wish we may take the extensibility elasticity and heat stability range of such a highly elastic rubber (Fig. 1) and arbitrarily classify any value for any of these properties which falls below 50 percent of the corresponding value for the base rubber, as being a plastic property rather than a rubber property. Such figures might be as follows:

TABLE I.—NATURAL RUBBER

	Vulcanized pure gum	*Vulcanized tread*
Elongation, %	750	600
High-speed elastic recovery, %	90	70
Stable temp. range, ° F.	250	250

Organic polysulfide is an intermediate between rubber and plastic. One type—Thiokol N—is of interest, not because it is necessarily representative of the group, but because it was tested for tire and retreading work and found to be rather close to the borderline (Fig. 2). It may be instructive to compare the figures for this material in a tread formula, with those for natural rubber, just presented. From these figures you will see that they average a little better than 50 percent of those for rubber. The average is $\frac{1}{3}(0.58 + 0.69 + 0.64) = 0.64$. The weighting of these factors is a problem of requiring judgment based on more experience than is presently available. It is probable that if an average is used the dividing line should be somewhat above 50 percent.

TABLE II.—THIOKOL N

		Natural rubber %
Elongation, %	350	58
Elastic recovery, %	48	69
Stable temp. range	160	64

Now to turn to plastics again, it is natural for the rubber man to speculate about the effect of vulcanization upon a plastic whose structure would seem to lend itself to such treatment. This has been done in the case of a vinyl vinylidene copolymer (Fig. 3). You will note from an examination of the stress-strain curves (Fig. 4) that the chief effect appears to be an increase in the tensile and elongation. The effect on our 3 essential properties is as follows:

III.—EFFECT OF VULCANIZATION ON POLYVINYL VINYLIDINE CHLORIDE

	Unvulcanized	*Vulcanized*	*Natural Rubber %*
Elongation, %	200	275	46
Elastic recovery, %	23	33	47
Stable temp. range	150	200	80

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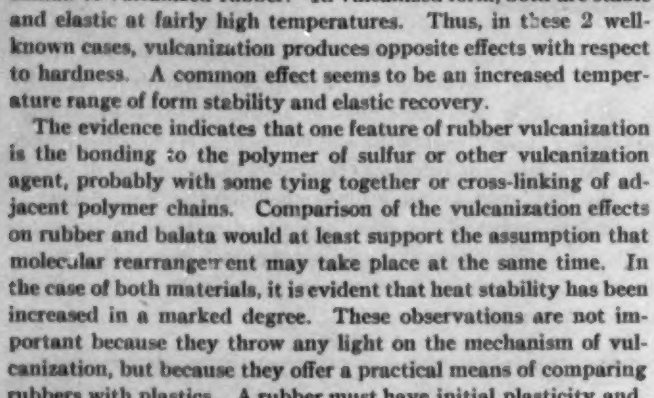

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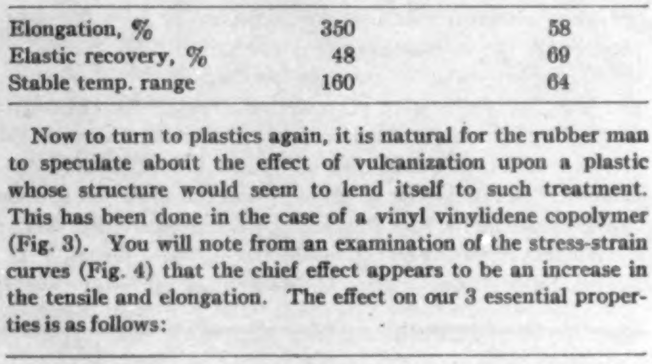

It will be seen that the vulcanization of this plastic has brought it an appreciable distance along the road which separates the true plastic from the true rubbers. It offers an interesting field for investigation and supplies a possible bridge between certain plastics and rubbers. It is not intended to imply that all types of plastics are susceptible to such treatment.

The foregoing gives us some basis for judgment of GR-S (butadiene-styrene copolymer) as a rubber (Fig. 5). Let us compare the essential properties:

TABLE IV.—COMPARISON NATURAL RUBBER AND GR-S

	Natural rubber tread	*GR-S tread*	*Natural rubber %*
Elongation, %	600	500	83
Elastic recovery, %	70	55	79
Stable temp. range	250	250	100

Here we are well over on the rubber side. The average ratio is 87 percent. Support can be found for ratings both above and below this figure. Nevertheless, it may be of interest to point out some of the practical drawbacks involved in the use of this rubber, just now of such great national importance. Natural rubber although maintaining its elastic recovery over a considerable range of temperature suffers a loss in strength and stiffness as the temperature rises. Thus a natural rubber tread as its temperature rises from 82 to 200° F. maintains a constant elongation but loses about 35 percent in breaking tensile. A GR-S tread subjected to the same change of temperature suffers a loss of 35 percent of its ultimate elongation and a drop of 66²/₃ percent in tensile. This serious difference between the natural and synthetic rubbers is accentuated by a similar drop in the tear resistance of the latter amounting to about 60 percent. The sole compensating feature is that the hysteresis loss likewise falls off sharply.

It is unfortunate that vulcanized GR-S, when subjected to temperatures in the vicinity of 200° F., has a pronounced tendency to vulcanize or perhaps to polymerize further and to fix its hot characteristics of lowered tensile, elongation and tear-resistance, even after the temperature has been reduced. Thus, when the rubber is flexed rapidly as in a tire, there is a pyramiding of bad effects. The high hysteresis raises the temperature which tends to result in fatigue cracking, chipping, separation and heat-bruising, while gradually the rubber is being degraded so it will suffer many of these defects even in a cool condition. It is of interest that the observed effects of tires are serious in proportion to the temperatures generated. Thus, in passenger tires operated at moderate speeds (under 40 miles per hour) little difficulty is experienced. At higher speeds and high road temperatures, tread cracking, carcass separation and bruising begin to appear. In the thicker bus and truck tires the natural tendency to produce high tire temperatures is much more pronounced.

These observations give a certain basis for judging the rubber criteria selected. They perhaps cast doubt on the reliability of the figures for temperature stability range and suggest that, since no rubber is completely stable over a wide temperature range, such figures should be weighted by taking into account the decrease of important properties. For a requirement as exacting as for tires, it is probable that if any essential property falls much below that for natural rubber, difficulties will be experienced. It should be pointed out that rubbers may be compounded and vulcanized in many ways. Natural rubber technique has been developed over many years, and it would be surprising if the best technique had been developed as yet for synthetic rubber. It is also true that, where temperature development and rapid flexing are less in evidence as for example in shoe soles, the rating of GR-S is undoubtedly much higher.

A glance at some of the other synthetic rubbers is sufficiently instructive to justify the brief time required. Buna-N or butadiene-acrylonitrile copolymer is valued chiefly for its oil and solvent resistance. It is somewhat less plastic in the unvulcanized state and, after vulcanization, it has about the same extensibility as GR-S, but it has less complete elastic recovery and a narrower range of temperature stability. Neoprene, polychloroprene, has a higher elongation, a somewhat higher elastic recovery and shorter temperature range, than GR-S. In the unvulcanized state, it has considerably less plasticity at normal room temperature than does GR-S. Butyl rubber, or isobutylene-isoprene copolymer, is a very soft plastic rubber, which when vulcanized, has a high elongation, low elastic recovery and a short temperature

1—Stress-strain curves, natural rubber pure gum and tread stocks. 2—Stress-strain curve, Thiokol-N, tread stock. 3—Polyvinyl vinylidene chloride. 4—Effect of vulcanization on polyvinyl vinylidene chloride. 5—Stress-strain curves, GR-S pure gum and tread compounds

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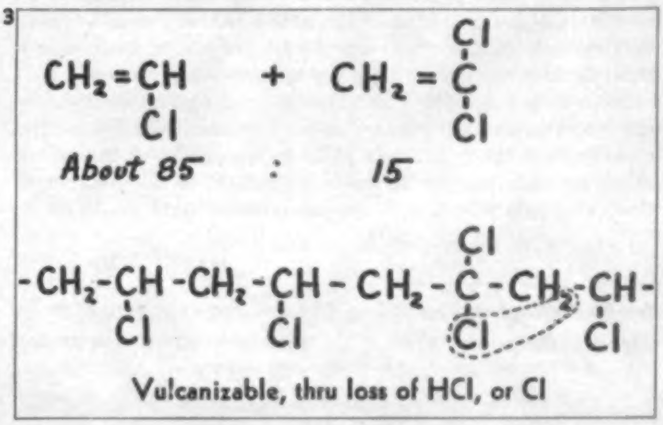

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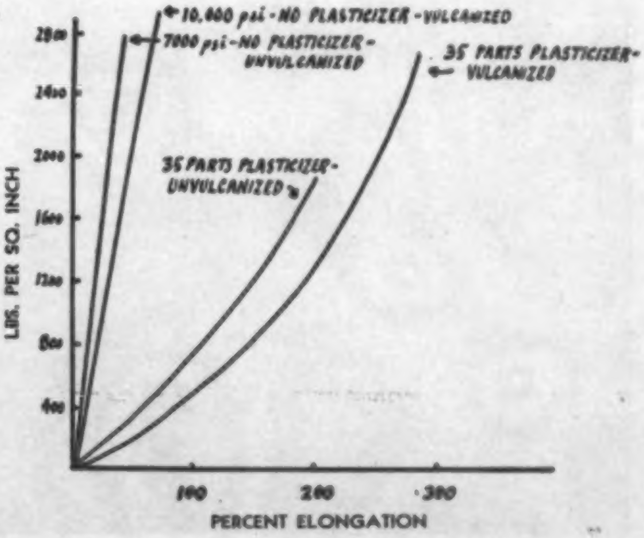

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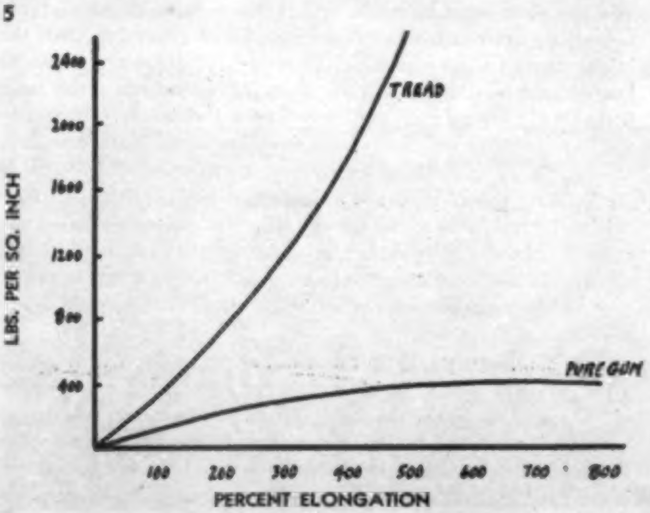


range. A study of the structural formulas of these polymers leads to some interesting speculation with respect to the effect of the rubber properties of the various constituent groups. As in other cases, however, no satisfactory conclusions are possible without a more detailed knowledge of the linkages. It is unquestionably true that most, if not all of these polymers are mixtures of different polymeric magnitudes. A study of molecular weight distribution curves and fractionation or the use of modified polymerization procedure, to change the distribution, will lead to information on enhancement of rubber-like properties.

When we examine the imposing list of plastics with their varied properties we are impressed with the wide utility of this class of materials. The gaps in their ranks only serve to emphasize the abundance of those already known. If we reflect upon the rapidly growing family of synthetic rubbers and realize that vulcanization will serve to link more closely many plastics with the rubbers, we will be obliged to agree that the time may not be far distant when known resins will form a continous chain of properties from the truly plastic to the truly elastic. At the two extremes we may expect the appearance of plastics as transparent and hard as glass, although much less fragile, and rubbers more truly elastic than natural rubber while more extensible and durable.

The final speaker at this first session of the convention was James Bailey of Plax Corp. Excerpts of his talk on "Extruding Polystyrene" are included here together with several illustrations which serve to high-light his remarks.

Extruding polystyrene

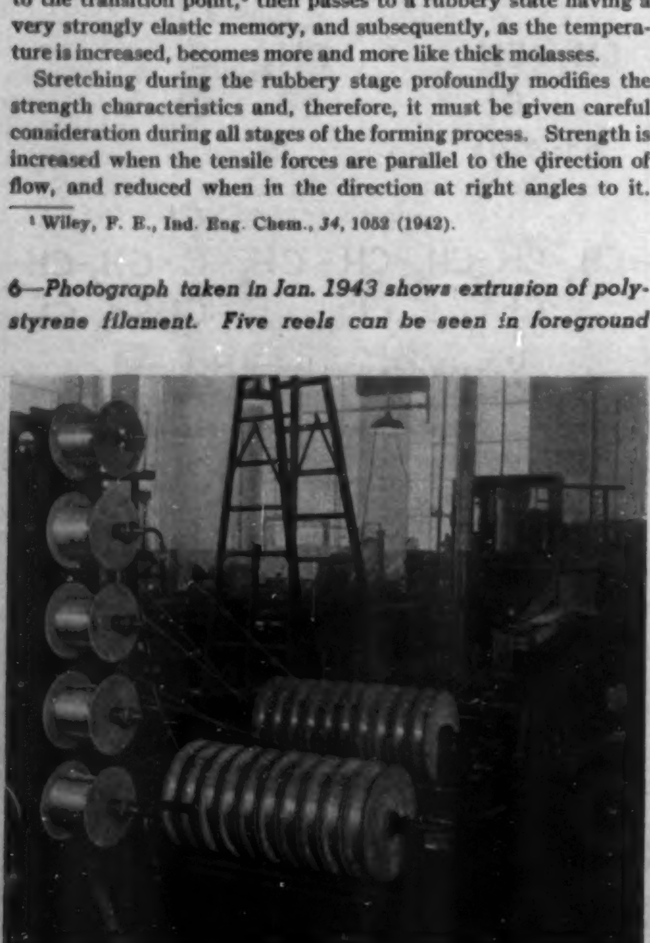
Old in the history of plastics but young in use, polystyrene has many useful properties and many mechanical limitations. These latter limit its usefulness to parts which are manufactured under certain definite rules and to applications where the applied stresses, from whatever cause, are held to relatively low values. Moreover, polystyrene belongs to that class of thermoplastics which, upon heating, remains relatively hard and unchanged up to the transition point,[1] then passes to a rubbery state having a very strongly elastic memory, and subsequently, as the temperature is increased, becomes more and more like thick molasses.

Stretching during the rubbery stage profoundly modifies the strength characteristics and, therefore, it must be given careful consideration during all stages of the forming process. Strength is increased when the tensile forces are parallel to the direction of flow, and reduced when in the direction at right angles to it.

[1] Wiley, F. E., Ind. Eng. Chem., *34*, 1052 (1942).

6—Photograph taken in Jan. 1943 shows extrusion of polystyrene filament. Five reels can be seen in foreground

6



Any solid body has, of course, three dimensions. Let these be designated by the common mathematical axes X, Y and Z. Generally considered, in a completely unoriented piece of material, all the physical, optical and chemical properties would be the same no matter in what direction they were measured. If the piece were stretched along the X axis, it would become weaker if measured by tensile testing along either the Y or the Z axis. Indeed, sheet stock which has been so stretched to perhaps four times its original length becomes so weak and brittle when bent crossways that essentially it is useless. Round rods or fibers which, because of their shape, cannot be bent sideways, show very enhanced strength and usefulness. The strength of such fibers can be raised from 7000 to 15,000 p.s.i., and a rod .050 in. in diameter can be bent double without breaking. If bent back and forth, it will split lengthwise showing the weakening parallel to the axis. Sheets of a few mils in thickness can, by orientation, be made to have a tensile strength of perhaps 20,000 p.s.i., and can be stretched cold up to 50 percent. However, these sheets are weak crosswise and up to the present time have been produced only in the laboratory.

J. BAILEY

If a piece is stretched along both the X and the Y axis, it becomes stronger in both dimensions but weaker along the Z axis. This procedure is practicable only in comparatively thin sheets since stretching to three times its length in both directions would increase the area to nine times and reduce the thickness to one-ninth. Sheets in the finished thickness of .020 in. or less are practicable and are sold under the trademark of "Polyflex." Sheets up to .010 in. can be bent double, punched, cut, sheared and otherwise handled without exhibiting the brittleness commonly associated with polystyrene. Tubes made from laminated flexible polystyrene sheet are remarkably strong to bending or collapsing forces, but are sometimes not entirely satisfactory for such things as pipe since the forces acting on the threads tend to tear them off.

Orientation cannot be done parallel to all three axes since this places the material in negative hydrostatic pressure and no flow results. This discussion of orientation is justified in a paper on extrusion only because it clarifies the effect of orientated flow upon the physical properties of the extruded piece, and makes it evident that the properties wanted must be considered before the shape is extruded. The effects of orientation are great or small according to the design of the dies and the temperature and speed of extrusion.

Shapes extruded stiff (plastic temperature less than 300° F.) and fast with powerful extruders and cooled rapidly, will exhibit pronounced orientation characteristics. Generally speaking, the hotter the piece is extruded and the less its shape is changed, the more even will be its strength characteristics in all directions. The use to which the extruded piece is to be put very often determines how the piece must be made, and in many cases the subsequent operations are much more complicated and expensive than the initial operation of extruding the shape. Rods which must be heated and bent in subsequent forming operations must have little elastic memory or they will contract violently. The same applies to tubing which has been stretched from a larger die to a smaller diameter. Flat sheets tend to warp and wrinkle if heated for bending unless they are manufactured under conditions resulting in relatively little orientation. On the other hand, the reduction in the brittleness caused by strong double stretching enables limited cold forming to be performed at room temperature and imparts qualities which make possible the shearing and punching of the sheet.

Extrusion.—In the broadest sense, any machine which pushes a material through a die is an extruder, and they are among the oldest machines in the mechanical arts. In modern parlance, an extruder is a machine which receives molding powder or stiff plastic and forces the material out through a die. Usually the material is softened by heat and mixed by the mechanical working of the

machine so that it issues through the die in a uniformly softened condition. There usually are at least 3 zones of temperature—a cold section where the powder is fed into the machine, a hot section into which the plastic is forced, and a die section having considerably hotter lips. With some plastics which are unstable to heat, 5 or more zones are used. With polystyrene which is perfectly heat stable when not in contact with oxygen, only 3 are necessary as far as the extrusion is concerned.

Generally speaking, polystyrene must be more uniformly heated than most other plastics. If this is not done, the extruded piece tends to readjust itself into the shape of the original grains, and the surface becomes lumpy and rough. Attempts to obviate this trouble by going to higher temperatures and using an extensive system of breaker plates is only partially successful owing to the poor heat conductivity of the material, and in many cases a higher temperature is not permissible.

Extruders currently used on our sheet machines are equipped with an auxiliary cold section which permits all of the extruder barrel to be heated to the same temperature. This is followed by a breaker chamber, also heated to the same temperature and the die section which may be heated by the same system of piping. The heating system consists of a centrifugal pump-driven, circulating oil system, using unusually large piping, heated by a thermostatically controlled gas heater. Uniformity of temperature is the object. Flash heating of the die lips on tubing and rod has been used, but thus far it has proved impracticable on wide, thin sheets. Speeds vary from 5 to 40 r.p.m. on the $^{3}/_{12}$-in. extruders, and outputs usually are between 20 and 70 lb. per hour. Generally speaking, it has been found more economical to sacrifice output to improve quality.

Screw design.—A design of screw suitable for the extrusion of polystyrene can be obtained from any of the manufacturers of extruding equipment. A single thread screw having a pitch at the hopper about equal to the diameter and a depth of one-eighth to one-ninth that of the diameter, of the variable pitch type, will give good results. For high back pressures, the pitch should reduce to about one-fourth the diameter, and the depth to about one-half that at the hopper. A single thread works very well, but the latitude of design is quite great and double threads can be used with good results. The pressure developed by the screw will increase with speed and will be greater at low temperatures. Tendency to surge increases with speed and is reduced by high back pressure.

Materials.—Polystyrene is neutral toward iron so that no special alloys are necessary for chemical purposes, but both the screw lands and the barrel must be hard to withstand the rather heavy back pressures which, in polystyrene, run from a minimum of about 700 to nearly 3,000 p.s.i.

Rods.—Before discussing the extrusion of rods of heavy section, the matter of cooling must be considered. Most polystyrene tends to develop bubbles when extruded into the atmosphere, and this is particularly troublesome when making heavy sections. These bubbles, however, can be suppressed by applying outside hydrostatic pressure to the plastic. That this bubbling is a vapor pressure phenomenon can be determined by laboratory methods, and this tendency to bubble becomes very great at sub-atmospheric pressure.

Polystyrene has a very low coefficient of thermal diffusivity and a relatively large modulus of elasticity. Therefore it is difficult to cool round rods larger than $^{1}/_{4}$-in. diameter from extrusion temperature to room temperature without inducing a vacuum in the interior. It follows that bubbling will result. A die was developed at our company of such design and length as to maintain the plastic at or near its softening point for a long period of time and at the same time hold the shape of the extruded piece and permit it to travel along through the die until the temperature at the center had dropped so low that bubbling would not develop. The controlling factor in cooling down a hot rod is the temperature at the center of the rod which must be reduced below the bubbling temperature before the outside pressure can be removed. Moreover, when the outer layers have hardened, the shrinkage of the hotter layers is resisted by the stiff exterior and eventually the hotter central core is thrown into a state of tension corresponding to a vacuum. This causes delayed bubbling if the piece leaves the die too hot.

While cellulose acetate and methyl methacrylate can be extruded with a glass-like surface, polystyrene is best handled at temperatures which give a frosted or matte finish. In some cases, polished rod is wanted which requires the removal of this frosted layer, hence rods are made from .005 in. oversize for small diameters to .015 in. oversize in larger diameters to permit finishing to exact size. After extrusion, the rod is carefully supported so as to permit equal cooling and to prevent surface marking. An automatic knife cuts the rod to any desired length except in the case of very small rods which go too fast, and very large ones which are usually cut by hand shears. Fine filaments are made by extruding through a multiple die.

Tubing.—Tubing is extruded in a strictly conventional manner. Everyone has experimented with the design of dies and found that it ultimately comes down to a series of very accurately held temperatures and speeds. Air pressures used in blowing or cooling not only must be oil-free and water-free, but carefully controlled as to pressure and temperature. The molding powder likewise must be of the kind having a very low volatile content, yet it must have reasonably free flow. Its grain size also must be uniform. While the detrimental effects of orientation resulting from too much drawing out have been discussed, it is possible, though difficult, to increase the toughness by blowing the tube to a larger diameter while drawing it out—thus giving it two-directional strength.

Unorientated sheet.—The equipment used to extrude unorientated polystyrene sheet consists of an auxiliary loader kept cool by water, an extruder whose entire cylinder is heated, a large homogenizer, completely heated, and a 16-in. wide nozzle. The sheet is drawn through a series of flattening rolls by a puller, then hand-cut to length. Sheets up to .090 in. thick 16 in. wide and of continuous length are made.

The resulting surface is a fine matte. The higher the tempera-

7—Machining a polystyrene disc. 8—This photograph which was taken in Aug. 1941 shows sheet extrusion of polystyrene

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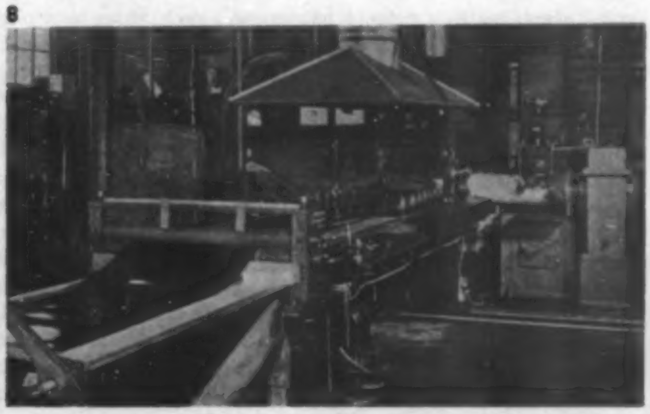

ture, the more glossy the sheet becomes, but the formation of fine bubbles at high temperatures precludes the possibility of producing a sheet having a high degree of gloss and transparency. The expediency of flashing the lips to produce a gloss has not been practicable owing to the large masses of metal involved and the difficulty of keeping a constant heating effect over such a great width. Irregular heating produces regions of off-gage thickness and warpage. Satisfactory sheet can be made from certain special grades of molding powder only. Press polishing has been resorted to in cases where gloss and transparency are required.

Flexible polystyrene sheet.—The general arrangement of the loader, extruder, homogenizer and nozzle is very similar to that used for extruding unorientated sheet except that the nozzle is narrower and designed to extrude a thicker sheet. The extruded sheet must be totally enclosed in a carefully zoned oven until the sheet is cool and stiff so that the temperature of the plastic undergoing stretching is accurately controlled. The forces involved in stretching the sheet are much larger than would be normally thought necessary. Since the sheet is stretched both laterally and longitudinally "on the fly," the movements must be accurately coordinated. During the stretching process, the area of the sheet may be increased from 8 to 12 times with a corresponding decrease in thickness. The stretching must be done in the rubbery temperature range, a short distance above its softening point.

One of the most persistent difficulties has been that of holding the gage. In the making of .010-in. sheet, the original extrusion will be about 12 times this thickness or about $^1/_{16}$ inch. Cooling of the thick extrusion will take place only at the surface, and we have already stated that the rate of cooling of the plastic half way between the top and bottom surfaces will vary inversely as the square of the thickness. Since the resistance to stretching doubles for a temperature drop of about 10°, it is obvious that any part of the original extrusion which is thicker than the rest will be much softer and will stretch much more easily than will the initially thinner and stiffer sections when the whole has dropped to the required stretching temperature. Minor variations in the extrusion cause variations in the longitudinal thickness. These, too, result in irregular stretching.

All in all, the development of this equipment has been a very long expensive job, fraught with discouraging failures and delays. Even now, only gages between .003 and .015 in. are regularly produced, although gages from .001 to .025 in. can be made. An interesting fact is that any defects such as a small bubble which would be $^1/_{16}$ in. in diameter in the extrusion becomes nearly $^1/_4$ in. in diameter in the finished sheet. Other defects are likewise magnified; in fact, best results were obtained only with special molding powder. Following the stretching, the sheet is gaged, slit, run through the puller and then wound into rolls.

Large rods.—Rods up to 8 in. in diameter have been produced. Such rods require so long a cooling time and are wanted in such small quantity that they are not commercially produced in continuous extrusion. They are produced in molds which are filled by an extruder.

Slabs.—Slabs are produced by two methods, according to size. In both cases, molten plastic is supplied from a conventional stuffer. In one instance a hot mold is filled and subsequently cooled according to a definite temperature cycle so as to avoid vacuum bubbles and surface sinks. In the other case, a special die is used, and the slab is made in continuous lengths. This die still is undergoing development, but it makes an extrusion with polished surfaces and an adjustable thickness which can be held within a matter of a few thousandths.

Extrusion blowing process.—In the blowing process which we employ, a cylinder very similar to that of an injection molding machine is employed to force plastic through a melting zone into a special cross-feed head. It then is extruded as a tube which usually is closed at the outer end. A mold is closed around the hot extrusion, and blowing air forces the soft plastic against the mold. Blowing air is usually maintained until the article has cooled sufficiently to permit removal from the mold. Bottles are the only article for which polystyrene has been used on this machine, excepting a few parts used for electrical equipment. Development of the process has been slow because of the low cost of competitive products and the chemical limitations of the plastics. Useful applications to date have nearly all been with the cellulosic materials.

Machinable polystyrene.—We believe that one of the most important contributions to the war effort is the discovery and application of a process of treating polystyrene which permits it to be machined. Without this process, extruded products, subsequently used as machined parts, would be worthless because of their mechanical instability. Probably 90 percent of our polystyrene rods, slugs and slabs are sold for ultimate use in some kind of electronic equipment. Much of the round rod is used in automatic screw machines and semi-automatic lathes.[8] Formerly, it was thought that polystyrene could not be machined because machined parts cracked erratically. The problem was referred to our laboratories and after an extensive study it was found that cracking is due solely to the thermal strains induced in the material. It was only after the discovery of a practicable means of evaluating the residual strains that a consistently machinable product could be produced.

The common method of measuring internal strain involves the use of polarized light. A relatively strain-free piece is prepared and loaded with a known load so that the resulting internal strain can be computed. Optical measurements are made which involve a rather complicated setup, and the stress-optical coefficient is measured. Knowing the stress-optical coefficient, the residual strain after any annealing operation (or during the annealing) can be measured. In the case of polystyrene, however, the system breaks down. In the apparatus for measuring strain, a series of parallel lines can be seen. If there is no strain, the lines remain unchanged with or without the test piece; strain causes a shift to one side for tensile strains, and to the other for compressive strains. Ordinary thermal cooling strains cause a shift of only a band or two. It so happens, however, that orientation as previously described which occurs during the hot rubbery stage also produces bands, often as many as 10 or 20, and they entirely mask the effect of the cooling strains. Contrary to what would be expected, these orientation strains do not contribute in any way to the spontaneous crazing or cracking, either before or after machining. A further complication is introduced by a reversal of sign in the stress-optical coefficient at or near the transition point. This seems to be unique with polystyrene, although not many plastics have been studied.

TABLE I.—SIGN OF STRESS-OPTICAL COEFFICIENT IN TENSION

Material	*Room temperature*	*Hot*
Glass	+	None
Cellulose acetate	+	+
Cast methyl methacrylate	−	−
Polystyrene	+	−

All of this befogs the measurement, since a) the common orientation effect is, perhaps, 10 to 20 times that due to the thermal stress and b) a thermal stress of great severity may be balanced by an orientation stress in such a way as to read zero. It was only after an entirely different means of finding and evaluating the residual strains had been discovered that commercially manufactured machinable parts could be tested. Moreover, the process of strain removal must be performed with a degree of exactness not easily maintained, and all lots of commercial products are tested to insure that they will be satisfactory in service.

Conclusion.—In bringing this paper to a close, it may be stated that the plastics industry is still building the foundations for its ultimate success. Plastics are not the general panacea for all structural difficulties which many people seek to believe. Applications must be carefully chosen to conform to the physical and chemical characteristics of the particular plastic. Much

[8] Wiley, F. E., Modern Plastics *21*, 80 (Aug. 1943).

more attention must be given to the proper forming and processing of the article. Plastics will never completely replace steel, wood, ceramics or glass—they should be considered as valuable adjuncts to the already common materials which form the bases of our older economy. The extrusion of polyestyrene must be considered in the light of all of this.

Following the luncheon which was presided over by George K. Scribner, president of the Society, and at which Commissioner William B. Herlands, Department of Investigation, City of New York, was the guest speaker, the members turned to business.

The Monday afternoon session, presided over by Allen W. Fritzsche, opened with a talk on "War Contract Termination" by Eric A. Camman of Peat, Marwick, Mitchell & Co. The following report represents a digest of Mr. Camman's speech.

War Contract Termination

It seems that up to now business men have been singularly indifferent to the gravity and complexity of the problems involved in cutting back and cancelling government contracts. Unless we consider these problems now, find the solutions to some of them and organize to deal with them effectively when they are upon us, it is not an overstatement to say that we face the possibility of a period of disastrous confusion and disorganization in our economic structure in the near future. Many questions of policy and procedure arise and more probably will be encountered as experience is gained. The aim of this article is to discuss some of these questions and to present the pros and cons to be considered. Any attempt at this time to suggest the answers to these questions would be premature. But a useful purpose can be served by the mere posing of the questions because the logical approach to the solution of any problem is a clear concept of the various questions involved. Bear in mind that the problems of contract termination are as much those of the contractor as of the government. It will not do for us to sit back and wait for some bureau or agency of the government to tell us what to do—a course which has been followed too often in the past. Three points are cardinal to a sound and effective program, namely: 1) prompt payments of contract settlements must be made, 2) reasonably clear settlement procedure must be outlined and 3) the general basis for computing the proper amounts of settlement must be established.


E. A. CAMMAN

Prompt payment.—The desirability of prompt payment is generally recognized and means of accomplishing it are being widely discussed. Senator Murray proposed to the Special Committee to Study Problems of American Small Business legislation which would make mandatory advance payments to war contractors and subcontractors. The Bill would require the governmental department involved to pay to the contractor within 30 days after he has filed a demand, 75 percent of the amount certified by him to be due with similar provisions with respect to subcontractors. In brief, the object of the proposed Bill is to overcome any delay on the part of disbursing officers in making payments through their natural tendency to protect their own accountability by insisting that every detail be checked and double checked and every sentence of every regulation be observed, through enactment of a law which makes the payments mandatory and leaves all the checking and reviewing, by inference, to a subsequent process.

Although this object is desirable, it is likely that any law passed by Congress making payments mandatory would contain so many provisions hedging about this authorization, for the protection of public funds, that in the end payments would not be made any more quickly than they could be made without legislation upon the administrative orders of higher authority in each contracting department. There are many who believe that payments should not be made mandatory by law. On the other hand, all our past experience with respect to payments by governmental agencies, indicates that without some practical impetus the payments to be made on future cancellations will be anything but prompt. PR 15 (War Department Procurement Regulation No. 15) in a number of paragraphs expresses the intention to make prompt partial payments and recognizes that interim financing is essential because many war contractors are greatly over-extended and are doing a volume of business wholly out of proportion to their working capital. Thus recognition of the need and intention to meet the need for prompt payments is clearly evidenced in PR 15, which may be regarded as the latest and most representative available pronouncement on settlement policy and procedure. Let us be realistic, however, and appreciate that the good intentions remain to be carried out and whether or not they can and will be carried out is another matter. This remark implies no reflection upon the sincerity of the expressed intentions.

The proposal of Senator Murray drew forth a reply on Sept. 20 from Mr. Lindsay C. Warren, Comptroller General, in which Mr. Warren views with alarm the consummation of negotiated settlements by the contracting procurement agencies and recommends legislation whereby, "After consideration of the claims of contractors and action thereupon in respect of advance payments, partial payments, loans or purchases, as provided in this act, the contracting departments or agencies having jurisdiction over the terminated contracts shall forthwith complete and consolidate the claims records by adding to the evidence submitted by each contractor in support of his claim such other pertinent supporting data as the Comptroller General of the United States may determine to be necessary and shall forward the claims records, so completed, together with a report and recommendation of the amounts and balances believed to be due the contractors under all such terminated contracts, to the General Accounting Office. The General Accounting Office is authorized and directed to examine and review the claims records including any advance payment or partial payments previously made, for the purpose of determining the legal and equitable obligations of the Government arising as a result of the terminations, and shall adjust and settle the claims and certify for payment such balances as it may determine to be due the contractors or the Government."

It should be apparent that if this suggestion is adopted it can operate only to seriously impede and delay, perhaps for years, the final settlement of terminated war contracts. There is a confusion of ideas here between proper auditing of departmental transactions and unwarranted auditing of contractors' accounts.

Admiral Emory S. Land, chairman of the Maritime Commission, has recommended that government contracting agencies have clear authority to effect settlements which would not be subject to review by any other governmental agency except for fraud. He further suggests that the general supervision with full authority to govern the termination of war contracts should be vested in the Office of War Demobilization. Very recently the National Planning Association has recommended the setting up of an entirely new governmental agency called the Office of National Reconversion to deal with 1) termination of war contracts, 2) disposal of surplus war materials and 3) reconversion of war plants. Without attempting to explore the merits of this idea one does wonder whether an administrator can be found and whether we really need another governmental agency.

Settlement procedure.—PR 15 prescribes certain forms and procedure for the filing of statements by contractors of their claims relative to terminated contracts. These forms are quite well devised and should be simple to follow. They should meet the requirements in the majority of cases for fixed-price contracts. It is recommended that the statements of subcontractors, which may be delayed in preparation and take longer to file than the prime contractor's own claim, should be filed separately at appropriate intervals. It is also recommended that the con-

tractor's statement of post termination costs, that is, the costs incurred by the contractor subsequent to the date of termination, be submitted separately. With respect to the contractor's own costs applicable to the uncompleted portion of the contract, 2 methods of calculation are indicated in PR 15—the inventory method and the total cost method.

Under the inventory method the inventory is to be priced in detail at unit costs. Obviously this method can be used only where such unit costs are available and particularly with respect to work in process when dependable unit cost information is at hand. Under the total cost method which is suggested as the alternative when unit cost information is not available and particularly when a clear and reliable segregation between the costs applicable to the completed and uncompleted portions of the contract is not at hand, the calculation is made by first summarizing the costs incurred on the entire contract to date of termination and then deducting all payments made or to be made for completed units. Under either method an appropriate rate of profit to be allowed, if any, is added. Both of these methods are sound and either is acceptable. The choice depends upon the circumstances although the option remains with the government to require the use of the inventory method where adequate cost accounting data are available.

The difficult and debatable part of these calculations relates to the appropriate profit to be added for the uncompleted portion of the contract. Long paragraphs are given in PR 15 indicating the many factors to be taken into consideration in determining a reasonable rate of profit. Conceding that it is not always an easy matter to decide upon a rate of profit that will be mutually satisfactory and considering that there may lie in this difficulty a cause for delays in settlements, the thought comes to mind whether it would not be far simpler and equally satisfactory to dispose of all questions regarding profit by stipulating a uniform standard of 6 percent on cost.

Two methods of settlement are prescribed in PR 15—the negotiated settlement and the formula settlement. By the term "negotiated settlement" is meant merely the reaching of an agreement between the contractor and the contracting officer upon an amount representing a fair settlement and this agreement is expressed in writing in a supplemental contract. Should such an agreement between the contractor and the contracting officer not be reached within 90 days, the amount of the settlement is to be computed by formula. The formula is contained in the standard termination article used in lump sum supply contracts, PR 324, which stipulates that the amount with respect to the contractor's own cost for the uncompleted portion of the contract shall be such cost plus an allowance for profit computed in the following manner:

A. The Contracting Officer shall estimate the profit which would have been realized on the uncompleted portion of the contract if the contract had been completed and labor and material costs prevailing at the date of termination had remained in effect.

B. Estimate from a consideration of all the relevant factors the percentage of completion of the uncompleted portion of the contract.

C. Multiply the anticipated profit determined under A by the percentage determined under B. The result is the amount to be paid to the Contractor as a proportionate share of profit, if any, as above provided.

The negotiated settlement method is the one favored by the War Department because it is the most expeditious and efficient procedure. It also is felt that the negotiated settlement is final and not subject to review in the absence of fraud by the office of the Comptroller General. On the other hand and for reasons which are not clear, settlement by formula is deemed to be subject to such reviews.

With respect to auditing of contractors' termination claims, there is ground for concern about how all the claims which eventually will be filed are to be properly reviewed. The accounting staffs of the contracting agencies are not adequate in number to handle all the work expeditiously. Hence it follows that much of the work of review must be done before the claim is submitted, either by the contractor's own accountants or by public accountants or both. In the cases of the numerous claims of subcontractors, for example, it would greatly expedite the processing of the filed statements if they were accompanied by a report indicating the review by the company's auditor, that is, an independent public accountant.

Settlement basis.—Coming now to the basis for determining the amounts to be paid in settlement of a terminated contract, it is important to recognize that there is a distinction and there may be a difference between termination costs and going concern costs. For another example, leaseholds may have been entered into for the performance of a contract, the life of which is not expired when a contract is terminated. The cost of such leaseholds when the facilities are of no further use to the contractor is obviously incurred for the purpose of the contract and should be included in the statement of claim, although on this subject PR 15 is silent. In cases in which the last-in-first-out method is in use, which usually will be cases involving common materials, the situation upon the termination of a contract must be very carefully considered so that the settlement shall be equitable to the contractor.

PR 15 excludes certain items from cost reimbursable upon termination of a contract, notably amortization, interest and reconversion costs. No reason is given why amortization is excluded, and it appears unjust that it should be. As to interest, PR 15 states that interest may be included in a settlement claim only in cases when the contractor does not provide for any allowance for profit, stipulating further that the interest can be definitely related to the cancelled contract. The reason for this exclusion is also not given, and it is difficult to understand why interest charges legitimately incurred for the performance of war contracts should not form a part of the cost of the undertaking. There is a tendency also on the part of renegotiators to exclude interest from allowable costs upon renegotiation. I am informed that the reason for this inclination is that it is thought to be unfair to contractors, who are able to finance themselves and therefore incur no interest charges, to allow interest to other contractors. It would be more equitable to allow interest in cases where it is properly incurred, and, in cases of other contractors who have no interest charges and have financed themselves, to take this fact into account when determining the reasonable margin of profit upon renegotiation, allowing such contractors slightly more profit.

With respect to VT loans which a number of contractors are taking out for the purpose of having a line of credit available upon which they can draw to replenish working capital which is tied up in war production and particularly in terminated contracts which may be subjected to delays in settlement, the question arises whether the commitment fee and interest charges on borrowings under the agreement are chargable in their entirety to war production or should be allocated in some equitable manner between war production and other production in cases when a contractor still is engaged to some extent in commercial production. They are not intended to meet the capital needs of ordinary business. If the credit is drawn upon to provide funds for use in connection with continuing war production contracts to free a part of invested working capital for other purposes, the transaction still relates to war production. The fact that the company is engaged in war production should not operate to confuse the right of the company to devote its own invested working capital to such use as is to the best interests of the company and it stockholders. The funds which are borrowed were borrowed to carry on war production.

In my opinion the commitment fee represents the cost of protection against a lag in payments on termination of war contracts and interest charges on borrowings would arise from the same cause or from financing continuing war production, all of which together relate entirely to war production contracts except in the event borrowings should exceed the reasonable working capital requirements for all war contracts. In such a case a ratable share would pertain to other than government business relative to the excess borrowings.

The expense of conversion of the contractor's facilities to

uses other than the performance of the contract are specifically excluded in PR 15. It seems to be recognized that the costs of reconversion arise from war production, and it is generally admitted that the costs of wartime production should be related to wartime income. Yet we find reconversion costs ruled out for tax purposes and for termination settlements largely because of the difficulty of their calculation. The situation therefore is that the principle is accepted but because it is difficult to carry out it is not followed.

No mention is made in PR 15 of separation pay or dismissal wage allowances. Presumably provisions for such future payments in current costs of terminated contracts would not be allowed. Here is another item of cost which is definitely related to wartime production although the actual expenditures will be made after the war ends. But again in many cases the suitable provision will be difficult to calculate. Some contractors have very definite plans which have been in force for years and did not arise because of the war, which are of the nature of a contractual obligation to make certain payments when employees are released. Surely in these cases it is evident that the cost of providing for future payments is definitely a part of the current cost of employment and production.

The prudent course of the contractor with respect to these debatable items of cost which now are held to be inadmissable will be to set up his accounts in such a manner that they can be determined properly with relation to government contracts notwithstanding that they may not be allowed for settlement or in renegotiation.

"Plastics in the Home of the Future" by Alden B. Dow, architect, was the second subject to engage the attention of the members at the afternoon meeting. The following digest gives the high-lights of his address.

Home of the future

The purpose of a shelter is to protect us from the elements, to provide basic physical comforts, to fill the animal needs of man.

A. B. DOW

The purpose of a home is to satisfy a fundamental need which goes beyond mere utility. Shelter today must have a sewer; hot and cold running water; separate rooms for bathing, sleeping and cooking; a heating unit; electric lights; telephone; storage space for the car; schools and playgrounds nearby; and paved roads with transportation services. A home is something more. It is the place where the individual's creative instinct has a free reign. Today we are neglecting this instinct. We are trying to pacify it with such things as the radio, moving pictures, travel, and higher wages; but as long as man fails to express his own individuality, he remains dissatisfied and unhappy.

The new architecture is a manifestation of this need. Some think that this development of the individual can be achieved in mass form through organized play and various kinds of clubs. But in the face of this argument, many families are moving out of our organized, regimented forms of housing into shelters in rural and suburban areas which are less comfortable and convenient, and often more expensive. This trend is due to the fact that in his own home the individual wants to reign supreme.

If a great development is to come in architecture and in plastics, it is going to be concerned basically with new ideas, ideas that will stimulate the growth of the individual. Until today architecture in this country has been primarily an interpretation of past ages. The new architecture, however, attempts to interpret our own ideals. Architects are approaching the plan not from the point of view of exterior appearance or style, but from that of function. They analyze the use of color, surface and space relationships with the same purpose in mind—that of human needs.

As the first example of this new approach, there is the function of appearance. The eye sees everything in terms of color. It demands surroundings that have a balanced variety of color for we cannot live in a room in which everything is brown or green or blue or any other one color, without upsetting the equilibrium of our visual mechanism. Monotony of form has the same reaction upon our visual system as monotony in color.

This simple principle of variety may be obvious, but we have overlooked its application both to building and to our way of living. Not until we apply this principle shall we see real direction in the form of our architecture. It is the duty of architects to keep this principle of balance before the builders and it is the duty of industry to furnish the home builder with materials that will make the application of this principle possible. We do not want buildings, one a replica of the other, rolling from a mass production line across our country. We do not want stock houses that can be traded in on a new model every year or so. We want a flexible material, varied in color and texture, from which the individual may build anything his heart desires, and add to it as the years go by. This may seem like wishful thinking, but it appears as though the plastics industries have the materials that may meet every requirement for simpler and more flexible building.

In the past our simple structures have consisted of a frame with an outside cover and an inside lining, protecting an insulating quilt. Architects want one material that will serve all three purposes. Today, well insulated walls are an economic necessity. But in construction this insulation presents a complication. It is necessary to protect this insulation and to ventilate the cool side. We want an insulation unit, made up of individual air and moisture tight voids, that provides its own protection. We should like to be able to cut this with simple tools and fasten it to a wood or steel frame, and call that our finished wall and roof.

Then it should be possible to build walls and roofs that are translucent as well as brightly colored. Such a development of course, does not mean the end of windows which serve another function. But here again plastics may be used. Transparent areas may be like roll screens, opened by the simple method of rolling them up. Another real problem in a building structure is presented by the contraction and expansion of materials due to moisture and temperature. Plastics seem to have a solution in reach, for elasticity is one of their finest properties and a wall unit must have that kind of flexibility.

Floors are another problem that plastics should solve. They should be developed for exterior and interior use so as to appear in varying degrees of resiliency, and in a variety of textures and colors. For lawns there should be a plastic sprinkler system that is a complete network for very small pipes lying just under the surface of the grass and filled with holes that will moisten the lawn without producing a spray. It would be of advantage to be able to force insecticides through these pipes with no worries about their deterioration or freezing. Plastics are needed for extensive use in textured surfaces such as draperies. The general furnishings of our homes will find new inspirations in plastics, inspirations in which color and flexibility will be dominating characteristics.

Dr. W. Gallay, National Research Council of Canada, was the third speaker at this session of the convention. A summary of his talk on "A Novel Hot Gluing Technique" is given below.

Hot gluing technique

This method of gluing deals chiefly with a novel means of applying heat to a plastic in order to hasten the necessary chemical reaction which cures or fixes the plastic to a permanently hard, infusible and water-proof state. One of the most important immediate applications of this new development is in the manufacture of components of aircraft and ships. Laminated wood is far superior to a solid single timber of the same size and strength, in permanence and resistance to weathering and organisms. Plastics are far superior to the older types of adhesives. While considerable time now is required to set these glues before the wood structure can be put in service, the new process reduces the time from days to minutes. *(Please turn to next page)*

The process is a simple one requiring no machinery or apparatus and no plant conversion. No strategic materials are used and no trained personnel are necessary. It can be used just as readily to manufacture a ship's keel as a smaller structure. The method which was developed by Dr. Gallay consists essentially of getting heat into the plastic glue by making the glue itself a conductor of electricity. This is accomplished by incorporating into the glue a special form of carbon black which does not interfere with the action of the glue. The action of this electrically conductive glue then is the same as that of the wiring in a toaster or heating pad. The glue quickly becomes sufficiently hot to set and cure in a very short time. The process uses simply ordinary low voltage current obtainable everywhere. Simple types of presses, jigs or clamps can be used in putting pressure on the wood layers. The moisture content of the wood, usually a troublesome factor in gluing, is of little importance when this new method is used.

DR. W. GALLAY

Some of the important war materials whose production should be tremendously speeded by the new Gallay process are aircraft propellers and wing spars, ship's framing members and keels, laminated arches, engineering booms and timbers, bridge trestles and the like. Other plastic fields such as fabric laminates for heavy gear stocks and bearings also are affected and the method is very promising in its application to pre-fabricated housing.

At the close of the afternoon session there were meetings of various groups within the society. The Molders Group of the S.P.I. was called to order by the chairman, James B. Neal, Jr. of Norton Laboratories. The entire session was devoted to a consideration of the manpower situation. Dr. E. G. Bewker, Associate Director of the War Manpower Commission, Washington, D. C., addressed the molders and tried in so far as possible to answer all the questions directed to him by those present. He suggested that the West Coast or Byrne Plan probably would be adopted for critical labor areas. Under this plan subcommittees of the WMC decide on the utilization of labor in direct proportion to the production urgency of each plant and product. In emergency cases, he explained, actual transfers of laborers can and will be ordered. Before the meeting adjourned, Frank Carmen, Head of the Plastics Division of WPB, informed the molders that recommendations were being made to remove from Order L-159 all control of the use and distribution of used machinery, and to release materials to build molds for all products not at present completely banned from production. Nicholas A. Backscheider, Recto Molded Products, Inc., who also addressed the group, explained that a number of Ohio molders were studying workmen's compensation insurance with a view to standardizing compensation rates for molders throughout the country.

The Extruders meeting was presided over by chairman Elmer Szantay, Sandee Manufacturing Co. The meeting opened with a discussion on O.P.A. regulations regarding extruded plastics. While it was proposed that a committee try to set up a price formula, none could be established because each problem of the extruder was different. Mr. Szantay suggested the members get together with Mr. Peterson of R. D. Werner, for suggestions and ideas on their price problems. George Solenberger, Plastics Section, WPB, gave a résumé of basic materials available.

This Extruders Group plans to set up an advisory committee to clear problems of major interest to the extruders so that at the next meeting they will have further comprehensive reports on all problems related to their branch of the industry. Mr. Szantay was authorized to appoint the members of this committee.

The meeting of the Canadian Group was called to order by chairman A. E. Byrne of Canadian General Electric Co. A committee headed by Dr. Gallay, so far has had before it 7 or 8 problems of a confidential nature which were submitted by Canadian branch members. Recommendations of a confidential nature have been made covering such items as a battery box, tumblers, trays, various types of mess gear and an ammunition component. They will be available to all members after proper clearance. A. E. Byrne announced that Jan. 25, 1944, will see a meeting of the Canadian Branch of S.P.I. held in the Royal York Hotel, Toronto, Canada. This will be a full-day meeting complete with a large and comprehensive exhibit of plastic parts which have taken their place in the war effort. While this exhibit will be primarily Canadian, there will be included a number of items from the United States which the committee feels will prove of interest to the Canadians.

The principal business transacted by the Button Division meeting of which N. O. Broderson, Rochester Button Co., is chairman, was a discussion of an organization chart and a new set of bylaws. No action was taken, however, at that time.

The Tuesday morning session, which was closed to all but S.P.I. members, convened under the chairmanship of E. B. Crawford. The meeting was devoted to a talk on "Postwar Planning" by Chas. C. Livingston of Cruver Manufacturing Co., chairman of the Postwar Planning Committee. The following is a digest of his remarks.

Postwar planning

After making a full and complete report on the work of the promotion and advertising committee of this postwar group, Mr. Livingston pointed out that the next 18 months would be a very critical period in the history of S.P.I. He stated that his committee felt that the Society is at a jumping-off point. Either it would expand and reach as yet untouched heights in usefulness to its members or it would decline to a nonenity—there was felt to be no middle ground. He presented several well thought-out recommendations which will be given full publicity in a confidential bulletin submitted to members of S.P.I.

C. C. LIVINGSTON

Mr. Livingston said that this committee had decided that post-war competiton for plastics was going to be very severe due to the great development work which has been done on light metals and glass. The true values of plastics in all their uses must be presented not only to the large manufacturers but to the general public as a whole. So that a good job might be done on this promotion, 6 subjects had been placed before the full committee. Mr. Livingston listed these subjects together with their costs:

1. Sound movies to travel to various cities in the country, sponsored and publicized by a local civic-minded organization. Cost $150,000 to $200,000.
2. Traveling lecture display to various cities in the country, sponsored and publicized by a local civic-minded organization. Cost $100,000 to $150,000.
3. Permanent plastic display in key cities. Cost $100,000 to $150,000.
4. Institutional advertising by S.P.I. Cost $100,000 to $150,000.
5. Illustrated catalog to be distributed on national basis. Cost $300,000 to $400,000.
6. Annual exposition—each member to rent his own booth at various rates predicated on size. The exhibit to be self-liquidating with remaining profit going to the Society for possible use in No. 4 activity.

After presenting these 6 subjects to the members, Mr. Livingston stated that his committee had discarded Nos. 1 to 5 for very sound reasons and therefore were making No. 6 the Committee's

recommended first choice. It was recommended that this plastics show or exposition be keyed to either the Spring or Fall meeting of the S.P.I. It was also suggested that an outside organization specializing in this type of work take full charge.

Mr. Livingston expressed the opinion that the industry would derive many benefits from such a show. It would bring about closer acquaintanceship and disseminate practical knowledge regarding materials, operations, achievements and objectives. It would create an active interest in products, tend to bring about their increased use and create good will for the industry that should bear fruit immediately and in the years to come. Mr. Livingston said that such an exhibit would help develop new markets and hold existing markets. It would be the means of coping with a keen competiton from the products which have been displaced by plastics or from other products now being made in such abundance that they will have to develop large postwar markets.

During the luncheon which followed, George K. Scribner, president of S.P.I., urged the members to cooperate more fully in supplying statistical data with regard to labor and technical information. He said that while means were not yet available for gathering technical information in the industry, it should be obtained although it may be costly. Mr. Scribner suggested that city chapters might be set up so that monthly meetings could be held at which technical information could be exchanged as in other industries. He said that it was not advisable to be "tight" with information of this sort, for when it was balanced out you "will get more out of it than you put in."

William T. Cruse, executive vice-president of the Society, then urged the members to attend the meetings of the Pacific Coast and Canadian sections if possible. He said that the S.P.I. had been of value to members who have cases pending before the WLB. Another statistical activity of the Society, he continued, is coverage of operations for the purpose of contract renegotiation and in connection with the Bureau of Internal Revenue matters.

In describing the work of the S.P.I. Technical Committee N. J. Rakas divided the discussion into two parts. One phase of its activities has been along the lines of supplying information to the best of its ability as requested by various government, industry and Armed Force agencies. In order to avoid duplication of effort a "Plastic Industry's Joint Wartime Technical Committee" has been set up whereby S.P.I., PMMA and NEMA are represented. The function of this committee is to steer requests to the proper sources for immediate action and reply. If the answer cannot be found within this group, help is sought from outside sources such as A.S.T.M., National Bureau of Standards, etc. Whenever a request is directed to the Technical Committee, it is transmitted to the sub-committees for action.

The other phase of the Technical Committee is of larger magnitude. The committee has started work in preparing an S.P.I. Plastics Handbook. There has been a need for this handbook in the industry for some time. The committee is of the opinion that a loose leaf handbook could be started by gathering information now scattered throughout the industry. This handbook can be modified and brought up to date as time goes on. The plan is to select individual committees for each chapter. They will be known as Sub-Committees whose chairmen automatically become members of the S.P.I. Technical Committee. At present the Engineering Classification of Plastics Sub-Committee has been formed and it has met several times. A tentative classification system has been worked out at a recent 2-day meeting and the next meeting has been called for November 10, 1943.

In order to organize the remaining committees, a form has been circulated to the member companies of S.P.I. asking them to supply names of individuals whom they desire to serve on the above chapters. As soon as this information is in the hands of the Technical Committee, the new sub-committees will be appointed with their chairmen. It is proposed to maintain these sub-committees as permanent committees for the purpose of accumulating and arranging the information for the handbook and keeping it up to date. No approximate date can be set for the handbook until further progress is made. The committee believes a handbook on plastics will go farther in the industry if prepared by a group of individuals who represent the material makers, molders, fabricators and the consumer.

James Rodgers, Jr., presided over the Tuesday afternoon session of the convention. The first speaker on the program was Dr. A. J. Stamm, U. S. Department of Agriculture, Forest Product Laboratory, whose talk on "Wood and Paper Base Plastics" has been condensed for inclusion on these pages. Appropriate illustrations accompany the text.

Wood and paper base plastics

Wood and wood products are becoming increasingly important as plastic raw materials. Until recently they were used almost exclusively in the form of wood flour and wood pulp fillers for molding compounds and pulp preforms and in the form of paper for paper-base, nonstructural laminates. Wood now is finding use as the continuous phase in resin-treated, uncompressed wood (impreg) and resin-treated, compressed wood (compreg). The plastic properties of the lignin constituent of wood are beginning to be utilized. Wood is being partially hydrolyzed to free the lignin and remove undesirable hemicelluloses in the making of molding powders which require smaller quantities of critical phenolic resin than do older commercial phenolic molding powders, its resin economy being due to the fact that the lignin serves as a plastic constituent (hydroxylin). Improved resin-impregnated paper-base laminates are being made that have practically twice the strength of earlier commercial paper-base laminates (papreg).

A. J. STAMM

Impreg.—A number of desirable properties can be imparted to wood by the forming of synthetic resins throughout the structure from resin-forming constituents of low molecular weight that have an affinity for wood. Although the hardness and compressive strength properties of wood can be improved by mechanically depositing any solid material within the structure, permanent dimensional stability and related properties have been successfully imparted to the wood only with a few specific resinoids under specific treating conditions. This is due to the fact that materials such as fats, waxes, natural resins and appreciably preformed synthetic resins, because of their large molecular size and their lack of polarity, under normal treating conditions show no tendency to penetrate the cell-wall structure of wood and no tendency to bond to the wood. Tests have shown that any water resistance these materials give to wood is entirely mechanical in nature. They cut down the rate at which water can traverse the structure, but they do not change the final amount taken up and, consequently, do not reduce the equilibrium swelling. Thus it becomes apparent that a treating material with an affinity for the wood greater than that of wood for water should be used. Unfortunately, all such materials in themselves have a high affinity for water. This difficulty has been solved with treating agents that are selectively absorbed within the intimate cell-wall structure of wood and subsequently can be converted to water-insoluble resins within the wood structure while remaining permanently bonded to the structure.

The most effective treating agent thus far found is a phenol-formaldehyde, water-soluble resinoid that is not advanced be-

yond the phenol-alcohol stage. Resorcinol can be substituted for the phenol or furfural for the formaldehyde without loss of effectiveness. All urea-formaldehyde resinoids tried have proved to be too highly prepolymerized to penetrate the structure adequately, with the exception of dimethylol urea. Even this material when polymerized within the structure reduced the swelling and shrinking on an equilibrium basis to only 60 percent of normal in contrast to reductions to 30 percent of normal effected by phenol-formaldehyde resin. None of the thermoplastic resins or thermoplastic resin-forming systems thus far tried have effectively reduced the swelling and shrinking.

It was shown that the chemical affinity of wood for a resin-forming system can be gaged by the degree to which the resin-forming solution swells wood beyond the swelling caused by water alone. A 40 percent aqueous solution of a phenol-formaldehyde resinoid will swell wood about 20 percent more than does water. When this highly swollen wood is dried and the resin is formed within the structure by the application of heat, considerably less than normal shrinkage occurs. The oven-dry treated wood has a volume about equal to that of the green untreated wood. When an amount of resin equivalent to 30 percent of the dry weight of the untreated wood, an amount which causes practically the optimum reduction of swelling and shrinking, is formed in the structure, the specific gravity of the wood is increased only about 18 percent rather than 30 percent.

Difficulty has been encountered in properly distributing resin-forming chemicals throughout the structure of massive pieces of wood. The treatment appears practical only for veneer. The value of antishrink treatments of veneer which is normally built up into plywood might be questioned on the basis that, in cross-banded plywood, the fiber direction of one ply restrains the across-the-fiber dimension changes of the adjacent ply, thus mechanically reducing such changes. Swelling and shrinking cannot, however, be prevented mechanically. If the wood is prevented from swelling normally in the sheet directions it will swell in the thickness direction or internally into the fiber cavities. When normal plywood takes up and then loses moisture, the plies are continually working and, as a result of the unevenly developed stresses, face checking is more serious than in solid boards. Resin treatment, which reduces the swelling and shrinking to about 30 percent of normal, reduces the stresses to such an extent that checking is practically eliminated.

The treatment of wood with stabilizing resins also imparts appreciable decay and termite resistance. The reduction in this action, it appears, is due rather to the fact that the treated wood will not take up enough water within the cell-wall structure to support decay than to the toxicity of the resin.

The treatment of wood with stabilizing resins increases its electrical resistance as a result of the reduced hygroscopicity. Dry wood is an excellent electrical insulator, but it loses its resistance properties rapidly with an increase in moisture content. Resin treatment also increases the acid resistance of wood, but it does not improve the alkali resistance. The treatment of wood with 20 percent of its weight of resin may increase the compressive strength and hardness by as much as 50 percent. Most of the other strength properties are affected but slightly. Impact strength is the one property that is adversely affected. As the resin content of wood is increased, it becomes more brittle. Likewise, more uniform distribution of resin also increases brittleness.

To summarize, impreg has the following advantages over normal wood: 1) reduced swelling, 2) reduced checking and surface degrade, 3) improved resistance to decay and termites, 4) improved electrical resistance, 5) improved acid resistance and 6) improved compressive strength and hardness. These improvements are secured at the expense of decreased toughness.

Compreg.—Compreg is resin-treated wood that is compressed while the resin is formed within its structure. Although a number of different resins have been tried in making this material, none has proved as successful as phenol-formaldehyde. There are 2 types of compreg: 1) the older form, developed in Europe, which is treated with a spirit-soluble phenolic resin prepolymerized to the stage that it does not tend to penetrate the cell-wall structure and bond to the polar groups of the wood and, as a result, does not stabilize wood appreciably; 2) the form developed by the Forest Products Laboratory which is treated with a water-soluble, phenol-formaldehyde resinoid, as in the case of impreg, so as to form the resin throughout the cell-wall structure of the wood and bond it to the active polar groups of the wood. The latter form of compreg is much more stable than the former but tends to be more brittle.

The second type of compreg can be compressed to virtually the ultimate compression (specific gravity of 1.3 to 1.4) under a pressure of 1000 p.s.i., using practically any species of wood. The unstable form of compreg, on the other hand, requires pressures of 2500 to 3000 p.s.i. to compress the wood to the same degree. There is a still greater difference in the pressures required to compress the wood of the stable and unstable forms to intermediate degrees of compression.

A high degree of polish can be imparted to any cut surface of the Forest Products Laboratory form of compreg by merely sanding and buffing the surface. This easy way of restoring the finish would be an advantageous property of compreg or compreg-faced furniture. The natural finish is highly resistant to such organic solvents as alcohol and acetone which destroy most applied finishes. The water absorption of this type of compreg is both small and slow. The unstabilized or less stabilized forms may absorb 6 percent or more of water under the same conditions.

The stable type of compreg will swell only 4 to 7 percent in thickness upon prolonged immersion in water at room temperature. Blocks less than an inch long in the fiber direction will hardly come to swelling equilibrium when soaked in water at room temperature for a year. When dried to the original moisture content it will practically regain its original dimensions—indicating that the loss of compression is negligible.

9—Face checking of resin-bonded Douglas fir plywood after 6 months' exposure. A, untreated. B, treated with 30 percent by weight of resin. 10—Action of termites on 3-ply plywood treated with 30 percent resin, and untreated core that was immersed to half its length in a termite infested field. Core almost completely eaten

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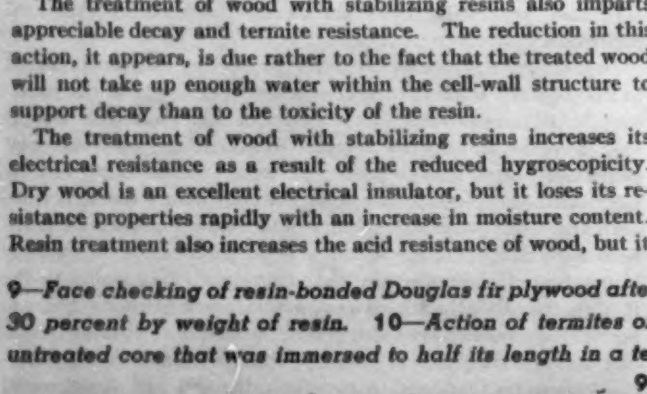

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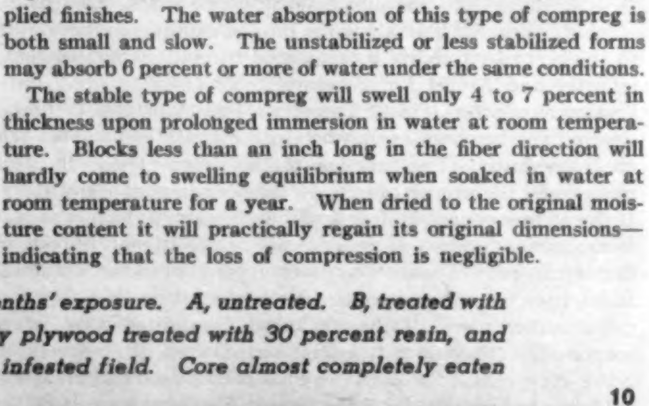


Most of the mechanical properties of the 2 forms of compreg are quite similar and, in general, vary about in direct proportion to the compression. Resin treatment prior to compression improves only the compressive properties and the shear strength in a plane at right angles to the direction of compression. Neither of these improvements, it is believed, is sufficient to warrant resin treatment unless it is accompanied by other improvements such as that of dimensional stability.

The impact strength of compreg, like that of impreg, decreases with an increase in the resin content and the intimacy of distribution of the resin, although impact strength, unlike the other properties, will vary to a certain degree with variations in the processing conditions. Under carefully controlled conditions, the stable form of compreg can be made from birch with an Izod impact value of 5 to 7 ft.-lb. per in. of notch. The unstable compreg will have an Izod value of 6 to 9 ft.-lb. per in. of notch.

An important feature of compreg is that it can be made from a great variety of woods, and obtain a product with properties which approach the optimum values. The only species to be avoided are the naturally resinous woods and those that are extremely difficult to treat, such as oak. Compreg can be machined easily with metal-working tools but not with woodworking tools. Consequently it is desirable to rough out the shape of objects prior to compression, using woodworking tools, and then compress them to the final shape in some form of mold. Treated, uncompressed plies are glued up into a blank of the correct size with a phenolic glue under conditions such that the treating resin is not cured and the bonding resin is but slightly cured.

Hydroxylin.—Lignin is nature's plastic which cements the cellulose fibers of wood together. A mild hydrolysis treatment breaks the cellulose-lignin bond of wood, freeing the lignin so that it can be used to rebond the cellulose fibers together. Wood waste, preferably hardwood sawdust or mill waste, can be hydrolyzed by several different methods. One procedure which has received the greatest attention is a hydrolysis with dilute sulfuric acid in a rotary digester at a steam pressure of 135 to 200 p.s.i. for 10 to 30 minutes. Besides breaking the cellulose-lignin bond, this hydrolysis treatment converts the hemicelluloses to sugars. These sugars, together with the acid, are washed out of the hydrolyzed wood and may be fermented to grain alcohol. The residue constitutes 50 to 60 percent of the weight of the original wood. As a result of the removal of part of the cellulose, the lignin content is increased to 35 to 40 percent. After drying, the hydrolyzed wood is quite brash and can be readily ground to a powder, preferably of 40 to 100 mesh. Although the lignin in hydrolyzed wood can be made to flow sufficiently for the molding of some simple objects by merely adding small amounts of water and pressing at 375° F., the flow is not adequate to give a product that is sufficiently coherent to stand long water immersion. Very similar results were obtained when nonresinous plasticizers for lignin were used in place of water, even though they did reduce the molding temperature. Hence it was found necessary to use auxiliary plastics or plastic-forming constituents together with a plasticizer for lignin when the added plastic material did not also serve as such.

The flow of this molding powder is not so great as that of the general-purpose commercial molding powders. This, together with the fact that the product cannot be drawn hot from the press, led to further research on the plasticizing of hydrolyzed wood. The best flow properties so far obtained have been with a molding powder containing 25 percent of phenolic resin and 75 percent of hydrolyzed wood. With this combination, the flow properties and the properties of the product are comparable with those of general-purpose molding compounds containing 50 percent of phenolic resin and 50 percent of wood flour.

The hydrolyzed wood-phenolic resin molding powders give molded products with flexural strengths ranging from 8000 to 13,000 p.s.i., water absorptions of only 0.2 to 0.3 percent after a 48-hr. immersion in water, and extremely high acid resistance. It appears to be possible to mold this material into thicker flawless sections than can be made of general-purpose commercial molding powders.

Papreg.—Paper laminates treated with phenolic resins have been made for years. They have been used chiefly for electrical insulating panels and for other nonstructural uses which do not require exceptional mechanical properties. The manufacturers, in developing these materials, have approached the problem primarily from the resin standpoint. It was felt at the Forest Products Laboratory that further development of paper-base laminates from the standpoint of finding the most suitable paper for the purpose, was a promising field of research. Within 6 months after the research was started, a paper-base laminate was developed that possessed several properties double those of the former laminates. Paper made on a paper machine is always stronger in the machine direction. The difference may be as much as twofold. When isotropic properties are sought in the laminate, alternate sheets are crossed as in plywood. Cross-banded papreg differs from plywood, and impreg and compreg with plywood construction, in that the strength properties are not so seriously reduced below the values for parallel-laminated material. Due to the fact that veneer is from 20 to 40 times as strong in tension in the fiber direction as across the fiber direction, the tensile strength of plywood depends almost entirely on the longitudinal plies. Cross-banded papreg has strength properties ranging from two-thirds to three-fourths of those for the parallel-laminated material, in contrast to the strength properties of cross-banded compreg, which are only about one-half as high as its parallel-laminated values.

Dr. R. H. Ball, Celanese Celluloid Co., was the final speaker at this session. The following is a digest of his talk on "The Cellulosic Family of Plastics."

Cellulosic family of plastics

Today the word "plastics" is used very loosely to cover both elastomers and rigid plastics—it even may refer to surface coatings, insulation binders, etc. In the cellulosic family we are dealing only with rigid plastics since none of the cellulose derivatives so far developed make satisfactory elastomers. In terms of physical properties we might define rigid plastics as those which re-

11—*Left to right, half of airplane tail wheel molded of compreg; a compreg specimen varying in specific gravity from end to end; model propellor molded of compreg; cut panel of birch compreg, sanded and buffed*

quire substantial force to deform them and which show only a moderate deformation under the stress of usage.

Production figures published on plastics usually lump together all their uses including not only the quantities used for plastic parts, but also such uses as surface coatings, impregnating compounds, binders for grinding wheels and brake blocks, plywood adhesives, insulating varnishes, etc. For this reason, the importance of the cellulosic family in the rigid plastic field is not generally appreciated. For the year 1943 it is believed that the production of cellulosic plastics will reach 75 to 80 million pounds. For the same period the production of all other rigid thermoplastics is expected to total 40 to 45 million pounds.

In proceeding to consider the properties of plastics either within the cellulosic family or between it and other types of plastics, general comparisons are not adequate. To make our comparison technically sound, we must go beyond the general properties of the plastics as they may appear in a table of properties and consider factors not yet adequately described by precise test data.

DR. R. H. BALL

Molding material.—Molding material presents a more complex picture than any of the other forms because of the variety of plastic products available. In the cellulosic field we have cellulose acetate, cellulose acetate butyrate and ethyl cellulose, each in a large series of compounds of varying properties. In the thermoplastic resin family we are dealing with methyl methacrylate, polystyrene, vinyl copolymer and vinylidene chloride. In the thermosetting resin group there are phenol formaldehyde, urea formaldehyde and melamine formaldehyde.

In the first place, the cellulosics are the toughest of all plastics, a fact which permits the molding of parts with sections much thinner than can be tolerated in other types of plastics. It is because of their toughness that cellulosic parts will stand a great deal of abuse without failure. Neither tensile nor impact tests provide adequate figures for estimating the toughness of a plastic. It is a property which depends to some extent on the ability of the material to elongate and flex without permanent deformation. But other factors are also involved, and the problem of a test method has not been solved. Since we are without figures for expressing toughness, comparisons between the different materials will have to depend on practical experience based on use. Vinyl copolymer probably comes nearest to equalling the cellulosics in toughness. Vinylidene chloride is in the same range as vinyl copolymer at normal temperature, but its brittleness at reduced temperatures must be kept in mind in its toughness rating. Methyl methacrylate is still lower down the toughness scale; polystyrene and the thermosetting moldings are at the bottom.

A second factor responsible for the wide use of cellulosic molding compounds is the great variety of formulations available. Special requirements in physical properties, special problems in mold design and peculiar machine conditions usually can be met by proper selection of compound. None of the resinous plastics offer such a variety of compounds. A comparatively wide selection is available in the phenolics but most of the other resins are produced only in 2 or 3 variations.

A third factor in the popularity of cellulosic molded parts is the range of colors available. Clear and colored transparents, mottles, translucents, pastels and opaque colors all are available in a complete range. Only 2 of the resinous plastics—methyl methacrylate and polystyrene—have a better basic clarity and freedom from color than the cellulose derivatives. This permits more delicately colored transparents, translucents and pastels in these two plastics. However, none of the resinous plastics can be produced with the color effects available in cellulosic moldings.

It always should be remembered that none of our present plastics are perfect. Cellulosic plastics, like all others, have their limitations. The most important of these is the fact that the cellulosics are thermoplastics. This is also an important advantage since by virtue of this fact they can be injection and extrusion molded and compete in cost per part with lower-priced compounds which must be compression molded. However, their thermoplasticity means that cellulosic molded parts cannot be used at temperatures above their softening point. Maximum temperatures permissible for the use of cellulosic molded parts vary in general from 150 to 215° F., and follow the flow temperature of the molding compound rather closely. The same limits in general hold for the resinous thermoplastics with the exception of vinylidene chloride which has somewhat better heat resistance than the average cellulosic compound, and vinyl copolymer which has lower heat resistance than most cellulosics. Where high temperature resistance is required thermosetting plastics must be used—the phenol formaldehyde plastics being outstanding in this respect, with melamine formaldehyde a good second.

A second limitation which must be kept in mind in using cellulosic moldings is susceptibility to moisture. In the softer flowing compounds it results in warpage of the molded part under humid conditions. In all cellulosic compounds it results in some change in the dimensions of the part with variations in humidity. Warpage usually can be overcome by proper selection of compound and also can be minimized by care in the design of the part. Expansion and contraction with humidity change in cellulosic parts normally is small enough to present no obstacle in the majority of uses. It usually can be accommodated by making proper allowance in the design of the part.

A third weakness in cellulosic plastics is lack of resistance to inorganic acids and alkalies. Of the cellulosic molding materials, ethyl cellulose is much more resistant than cellulose acetate or acetate butyrate. None compare with the resinous plastics in this respect. However all of the cellulosics are satisfactorily resistant to the milder organic acids, such as fruit, food and body acids. An additional point which merits discussion is resistance to solvents. Of the cellulosic plastics, cellulose acetate is the most solvent resistant. It is not attacked by aliphatic hydrocarbons such as oils and gasoline, and its resistance to aromatics and chlorinated hydrocarbons varies from good to fair depending on the solubility of the plasticizer. Attack by chlorinated hydrocarbons and aromatics increases as we proceed through cellulose acetate propionate and cellulose acetate butyrate to ethyl cellulose. The latter has a broad range of solubility but still is not attacked by straight chain hydrocarbons. Among the resinous plastics, the thermosets are unaffected by most solvents being superior to all other plastics in this respect. Vinylidene chloride and vinyl copolymer are generally more resistant to solvents than the cellulose esters. Methyl methacrylate is somewhat similar to the cellulose esters, while polystyrene is more widely soluble and resembles ethyl cellulose in this respect.

While the comparisons made above between the cellulosics and the resins are valid for the cellulosic molding materials as a group, there are individual differences in properties within the group which will influence the selection of compound for a particular job. With respect to toughness, ethyl cellulose is outstanding among the cellulosic molding materials. This holds at normal temperatures and is particularly evident at reduced temperatures. Cellulose acetate and acetate butyrate are pretty much equal in toughness if proper adjustment is made in flow temperature.

With regard to the variety of formulations which may be provided, all 3 of these cellulosics may be considered equal. Ethyl cellulose, being the newest, is not yet available in as complete a series of compounds as the other 2, but it is capable of an even wider range of formulations. On the subject of colors, there are some differences between these 3 cellulosics. Cellulose acetate has the best basic color and clarity, and can be converted into more delicate and brilliant colors. Cellulose acetate butyrate is a close second in this respect. Ethyl cellulose, because it is new, has the poorest color and clarity of the three.

Cellulose acetate and acetate butyrate are approximately equal in the maximum service temperatures which they will withstand. It is too soon yet to say that ethyl cellulose will excel them in this respect, but it can be said that in a compound of equal flow, ethyl cellulose will stand a higher temperature without distortion. There also are differences between these 3 cellulosics in moisture

sensitivity. It is not the amount of water absorbed that matters, but the effect of this water on the molded part. To give the same resistance to warpage, a cellulose acetate molding compound must be 2 or 3 steps harder in flow than the corresponding cellulose acetate butyrate. Below MH flow in cellulose acetate or MS flow in cellulose acetate butyrate, neither product has good resistance to humidity warpage. In this respect ethyl cellulose moldings are superior.

In acid and alkali resistance cellulose acetate and acetate butyrate are similar. Neither has satisfactory resistance to alkalies or mineral acids, although cellulose acetate butyrate will stand considerably longer exposure than cellulose acetate. Both will perform satisfactorily in contact with organic acids such as fruit acids. Ethyl cellulose, on the other hand, is a substantial improvement in this respect.

Sheets.—In turning to the consideration of sheets, it is found that the general physical property requirements differ sufficiently from those of molding materials to call for a different selection of plastics. Because sheet uses demand thinner sections than moldings, freedom from brittleness is of great importance. Stiffness also becomes a major factor. The high thermal decomposition point necessitated by the molding process also is reduced. For these reasons we find the selection of plastics materials for sheets confined to cellulose nitrate, cellulose acetate, cellulose acetate propionate, vinyl copolymer, methyl methacrylate and phenolic. For years cellulose nitrate was the outstanding sheet material, and it is still a very important one.

The sheet which combines the strong points of cellulose nitrate without its disadvantages is cellulose acetate. Burning rate and heat distortion point of cellulose acetate sheets are entirely satisfactory for most uses, and their light stability is excellent. Toughness and freedom from brittleness are outstanding properties although cellulose acetate does not quite equal cellulose nitrate in its optimum combination of stiffness with freedom from brittleness. Cellulose acetate sheets have greater expansion and contraction with humidity change than cellulose nitrate, and this must be allowed for in mounting sheets of large area such as those used in aircraft glazing.

Cellulose acetate propionate sheets have been produced in small quantities and represent a compromise in properties between cellulose acetate and cellulose nitrate. They are equal to the former in stability to light and heat, and in non-inflammability. They are equal to the latter in lack of moisture sensitivity. However, this has been accomplished at the expense of stiffness. Cellulose acetate butyrate is still lower on the stiffness scale, to the point where it is not attractive as a general sheet material. Ethyl cellulose sheet stock made by the block pressing method is not yet a commercial item. The outstanding properties expected in it are: toughness, especially at low temperatures, and lack of humidity sensitivity over a wide temperature range.

In the resinous plastic group there are 2 thermoplastics available in sheet form, namely, methyl methacrylate and vinyl copolymer. Both are stiffer than any cellulosic sheet. They also are more brittle than any cellulosic sheet, a limitation which is especially true of methyl methacrylate. Moreover, because of the methods used in their manufacture, their colorability is practically limited to plain colors. Methyl methacrylate, because of brittleness, cannot be produced or handled economically in gages below 40 mils, and serious breakage results even with 60 mil sheets. In heavier gages this sheet has several virtues which offset this weakness and account for its extensive use especially in aircraft glazing. Vinyl copolymer sheets although substantially more brittle than cellulosics are less brittle than methacrylate and still are tough enough for a good many uses.

In addition to these thermoplastic sheets, there is one important thermoset sheet—laminated phenolic. This sheet can be made only in black and brown opaque and is much more brittle than any cellulosic sheet. It cannot be heat formed and fabricated by the easy means adaptable to thermoplastics. Nevertheless, it has widespread and important use especially in industrial equipment because of form stability, resistance to moisture and chemicals and its ability to withstand high temperatures.

Rods and tubes.—In considering rods and tubes, the first point to note is that we have a wider selection of resinous plastics and a different selection of cellulosics. In the cellulosic rods and tubes there is production in cellulose nitrate, acetate and acetate butyrate, and in ethyl cellulose. No cellulose acetate propionate rods are being made, their place having been taken by cellulose acetate butyrate. The lack of stiffness of cellulose acetate butyrate is not so important a factor in rods and tubes as in sheets, because the heavier cross sections provide more rigidity. With the above exception, the same basic points of comparison discussed under sheets hold for rods and tubes.

There are 3 general processes for the production of cellulosic rod and tube, which affect the color combinations that can be attained. The block pressing method, similar to that used for sheets, permits great variety and exact configuration of color. Only cellulose nitrate and cellulose acetate rods and tubes now are made by this method. The "stuffing" process produces solid colors and random mottles. Here again only cellulose nitrate and cellulose acetate are made by this process. The dry extrusion process gives solid colors. Cellulose acetate, cellulose acetate butyrate and ethyl cellulose rods and tubes are all made by dry extrusion.

Resinous plastic rods and tubes may be obtained in methyl methacrylate, polystyrene, vinyl copolymer, vinylidene chloride and phenolic. Of these the phenolics are made by laminating, the others by extrusion. In dealing with sheets, a comparison already has been made between the cellulosic plastics and methyl methacrylate, vinyl copolymer and phenolics. The same comparisons hold for rods and tubes, with the added comment that most of the vinyl copolymer and considerable of the vinylidene chloride tubing has been of the plasticized or flexible type, and properly could be called an elastomer. Neither polystyrene nor vinylidene chloride was covered in the discussion on sheets. Both these plastics appear to be specialty materials when it comes to rods and tubes.

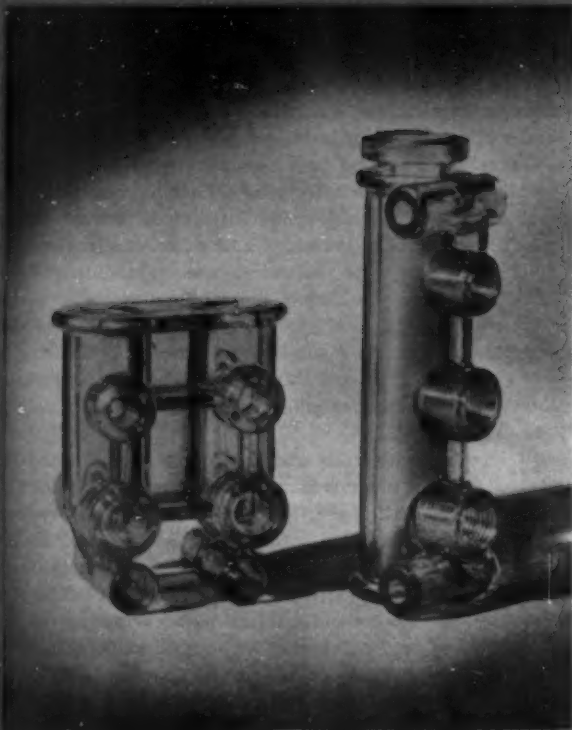
Film.—The cellulosic plastics have the field of film practically to themselves. All of the cellulosics are produced in film form. If we exclude elastomers, the only resinous plastic made as a film is a special polystyrene development. The major reason for the lack of film competition from the resinous plastics is that satisfactory film can be made only from the toughest plastic. Again in this field, cellulose nitrate has maintained an outstanding position in spite of the handicaps of inflammability and discoloration under ultraviolet light. Most motion picture film still is cellulose nitrate because nothing else can equal its projection life. However, to eliminate the hazard of storage and handling, X-ray and graphic arts film, and most aero and similar military film have been converted to cellulose acetate, acetate propionate and acetate butyrate.

Foil.—Foils may be defined generally as films with a thickness of less than 3 mils. Since their greatest volume of use has been as a packaging material rather than as a plastic, only a brief review need be made here. With the exception of saran and polystyrene, the resinous foils are all elastomers. Saran foil is very recent, and is creating interest because it is an excellent moisture vapor barrier. Polystyrene foil is being produced in small quantity for special electrical use.

In the cellulosic field, the major production has been in cellulose acetate with cellulose acetate butyrate also being made in some quantity. Both are approximately equal as a moisture vapor barrier. Both are satisfactory and vastly superior to regenerated cellulose foil in maintaining dimensions with age and humidity change. Cellulose acetate butyrate has a greater elongation in tension than cellulose acetate—an advantage for some uses and a disadvantage for others. Ethyl cellulose foil has been made in small quantity. As a moisture vapor barrier it falls in the same range as cellulose acetate and cellulose acetate butyrate. It is somewhat better in holding dimensions with age and humidity change. Its most interesting property, however, is its toughness where it excels both the cellulose esters by a substantial margin. This should lead to important usefulness in the packaging field.

PLASTICS

1



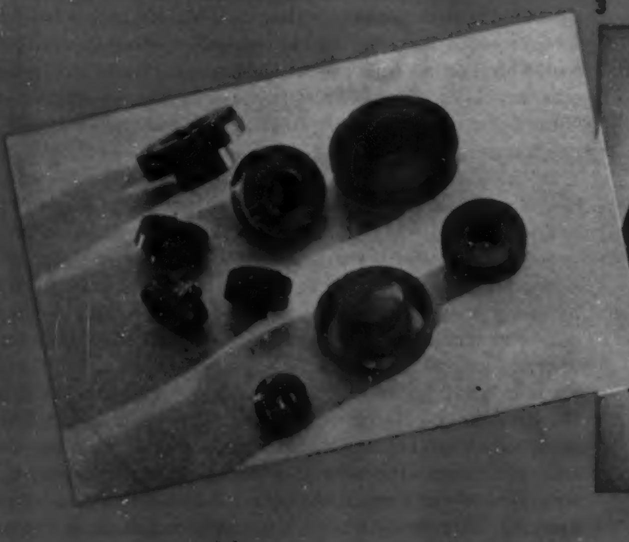
2

1 The North American bombers that are making a name for themselves over the world's battlefields, depend on 2 small Fibestos moldings for the efficient and dependable operation of their vacuum systems. These transparent vacuum blocks, part of the system that operates the instrument indicators, demand dimensional stability far higher than usually specified in cellulose acetate. North American tests show a variance of less than 4 thousandths of an inch under operating conditions. In addition, these blocks which are molded by Plas-Tex Corp., must have crystal clarity, ability to operate under 75 p.s.i. pressure over a wide temperature range and molded-in threads for attaching various fittings

2 Three hundred and twenty feet below the sea. At such a depth every step, every movement is frought with danger for the deep-sea diver. These risks have been minimized for 70 Navy divers in various parts of the world by a new-type helmet manufactured by the Diving Equipment and Salvage Co., with a large curved Lucite window. This transparent plastic window which replaces the former grilled peep hole, not only extends the diver's visibility but also reduces the weight of the helmet and thus increases the operator's maneuverability

3 Paint has a habit of spreading out over areas that should be left uncoated. To protect the threads on exposed piping in airplane assemblies during the painting operation, these Durez caps are screwed on the ends of the pipes. Not only do the caps eliminate the need for cleaning the threads after painting, but they keep dirt and paint from the inside of the pipes. Norton Laboratories, Inc., mold the pieces in sizes from $\frac{1}{8}$ in.–24 to 1$\frac{5}{16}$in.–12

4 Impellers on heavy-duty industrial blowers must be durable, light in weight and of precise proportions—qualifications which are met by these Resinox impellers used by the United Blower Corp. The fact that the 6 vanes on each of these parts are molded in one piece with the spider and hub, is a further important qualification. The problem of molding this intricate part with its long draws in an impact material, was solved by the H. Jamison Manufacturing Co., through use of a mixture of 2 types of Resinox, one of which was high-impact, cord-filled material



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IN REVIEW

5 Automatic milking machines are doing much to ease the strain of the manpower shortage on the farm. Helping in the work is this milking machine angle stall cock which is molded in two parts of Tenite II (see bottom picture). Two washers, a small spring and a cotter pin which can be seen in the foreground, complete the assembly. The plastic unit is molded in a 2-cavity die with a cam rack and pinion design; the die averages about 80 shots per hour. Because of the need for a perfect vacuum joint, extreme care is necessary to prevent shrinkage or collapsing of the pieces. The cock, shown assembled at the top, is molded by Continental Plastics Corp.

6 The destructive force inherent in Allied cooperation is well illustrated in this machete with a blade originated by a Filipino native and a handle designed by an Australian native pigmy. The knurled sides of the Lumarith handle, molded by Cruver Manufacturing Co., assure a firm grip. The steel shank of the knife, around which the handle is molded in a single-cavity die, has 3 prongs which serve as anchors. This handle construction assures complete insulation and permits the use of the knife in the cutting of high-tension barbed wire

7 This Viewmaster—a stereoptican arrangement—is streamlining the teaching of range estimation, angle, and plane recognition to members of the Army Air Corps and the Navy. Visual instruction in the identification of aircraft and surface ships is achieved through use of a disk with a number of colored views or pictures on regular 8-mm. film. The instrument is molded of Bakelite by Sawyer's, because of the material's permanence of form, heat resistance, moisture resistance, appearance and permanence of color.

8 Day and night Pan American Airways' Clipper Ships coast in for a landing or roar off on the next leg of their journey. To reduce the risk of such operations after dark, channel marker buoy lights are set out along the water take-off and landing area to outline the channel for the pilots. Each of these markers, in the form of small dinghies, support 2 cylindrical fluorescent lights manufactured by Day-Ray Products Co. These lights, encased in Lucite tubes, are set at different angles for all-around vision from the sky.

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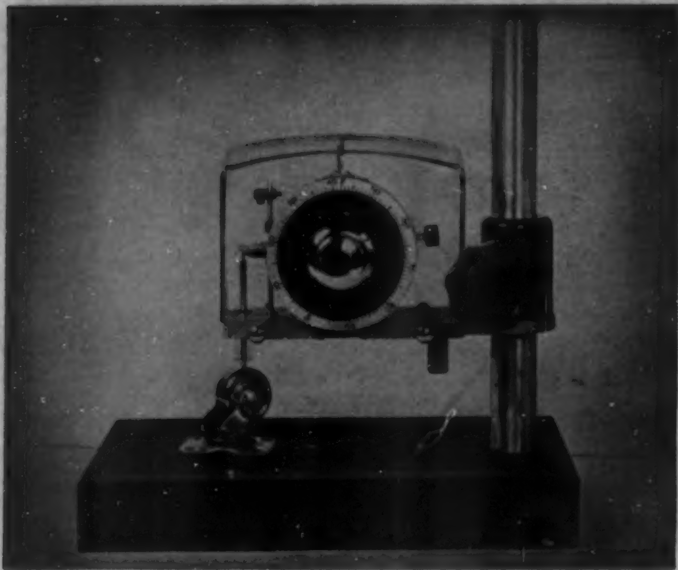
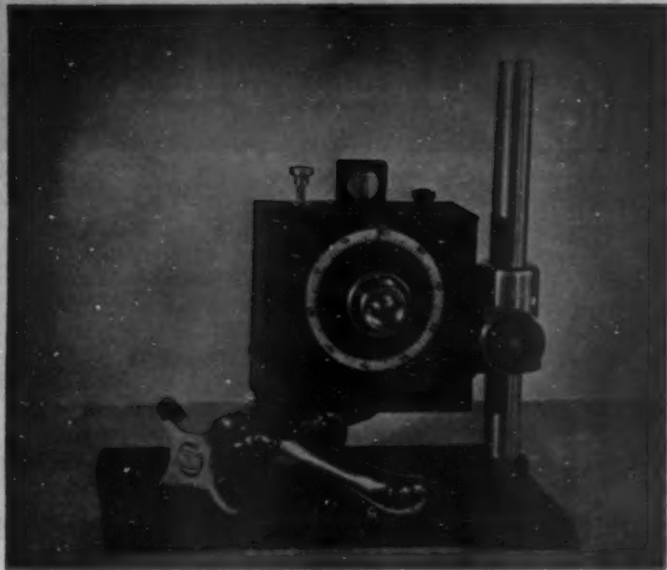




PHOTOS, COURTESY AMERICAN INSTRUMENT CO.

1—Three plastic parts in this redesigned metal gaging instrument are the phenolic knob at right, the laminated lignin base and the transparent acetate cover. 2—The former metal housing concealed the delicate inner mechanism which frequently was thrown out of balance by an accidental blow when the case was slipped on and off

Redesigned metal coatings gage

TOLERANCES are close on the end-products that comprise the bulk of our present war production. In cases of plated, painted and lacquered parts, the thicknesses of the coatings must conform to specifications if costly rejections are to be eliminated. In many plants the thickness of nickel coatings up to 0.001 in. on non-magnetic base metals, polished nickel coatings up to 0.002 in. on iron or steel, and non-magnetic coatings up to 0.080 in. on iron or steel, is measured by this Aminco-Brenner Magne-Gage.

The gage consists essentially of a small permanent bar magnet 0.08 in. in diameter freely suspended from a horizontal lever arm. The latter is actuated by a beryllium-copper spiral spring which is coiled by turning a graduated dial. The attractive force between the magnet and the specimen is indicated on the graduated dial. To measure thickness, the tip of the magnet is brought into contact with the specimen, and the dial turned until the magnet is detached. The first reading is approximate. Several more readings are taken and averaged. These are converted to thicknesses by reference to a calibration curve supplied with the instrument. The specimen always should be placed so that the magnet will be normal to its surface. While this gage may be removed from its stand when measurements are made on large objects, the instrument always should be used in the same upright position with the lever arm horizontal.

When copper became a critical material, the engineers of the American Instrument Co., turned to plastics as replacements for the copper and brass used in less precise parts. After the conversion it was found that the plastics actually enhanced the value of the instrument. This is particularly evident in the case of the acetate cover which the instrument company purchases from a large molding plant. Injection molded in a one-cavity die, this plastic part weighs 93 grams and is produced in a one-minute molding cycle. The emblem is raised on the inside at such an angle that advantage is taken of the critical reflectance angle of the material. As a result the letters take on a silvered appearance. As can be seen in Fig. 3, the border of the emblem is extended down toward the operator so that it can serve as an index for the pointer on the balance arm of the gage. Shoulders on the inside corners of the case permit the cover to fit on the metal base of the instrument. The small slots accept knurled head screw studs which hold the housing in position.

The transparent material proved to have several advantages over the former fabricated (*Please turn to p ge 170*)

3—After the laminated lignin base is sawed to size, it is wet sanded. The edges are beveled, and the hole drilled and counter-bored with high-speed tools. The small slots at the base of the transparent housing accept head screw studs that hold the case in position. A raised line on the inside of the cover extends down from the top emblem and serves as the pointer index

F. B. Stanley, Engineering Editor

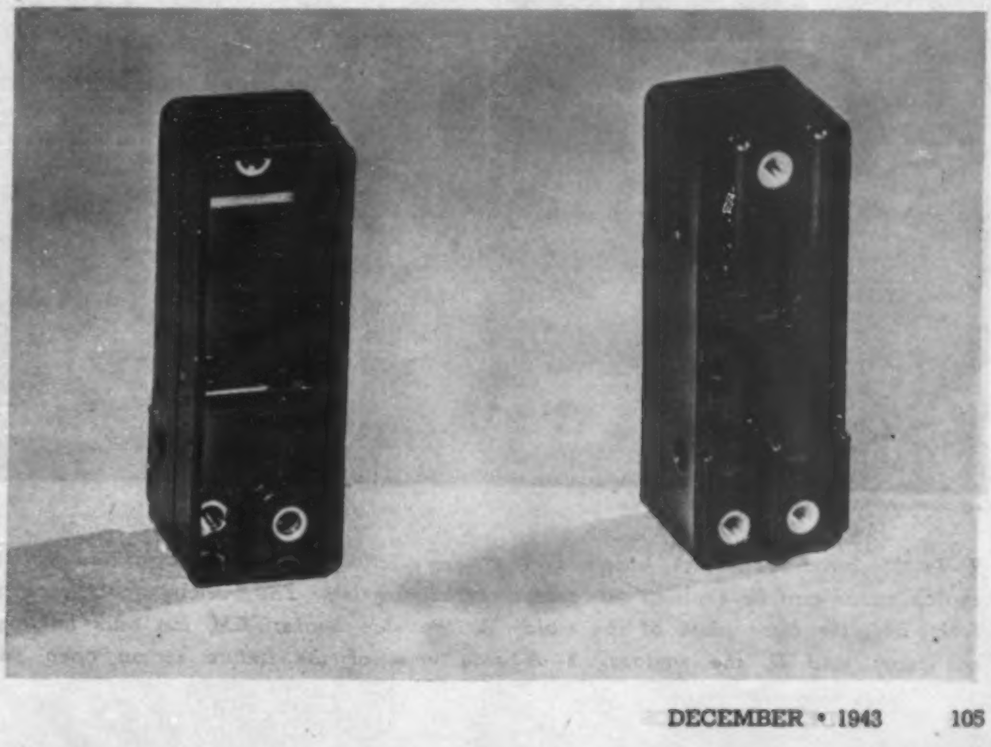
Automatic hand molds

THE demand for electrical contact switches which are positive in operation, make and break instantaneously, and indicate closed and open circuits with a contact motion measured in tenths of thousandths of an inch, has been experiencing a tremendous growth. While there are many important uses for this type of switch, one of the most important rests on the close tolerances stipulated in many of today's war contracts. The delicate mechanism of these switches makes possible the operation of electrical indicators which can be used in gaging tolerances on the order of ±.001 inch. An example of this application is the set-up in a large mid-western molding plant for the gaging of the M-52 plastic fuse which has become well known to the industry because of the extremely close tolerance required of the finished piece. At this company several dimensions which previously had been laboriously hand-gaged with plug "go and no-go" type gages now are measured through the use of electrical indicators equipped with Micro switches. The adoption of this method has materially reduced the time required to check the close tolerances demanded on these plastic fuses.

The phenolic housing for this switch is about 2 in. long and there are five lugs on the underside of the case. As can be seen in Fig. 1, the design of the switch case calls for three threaded inserts molded vertically and two horizontal molded-through holes. These horizontal holes immediately changed the molding of this tiny housing from a simple to a very complicated job. Two cylinder core pins which must be withdrawn in some manner, are required for the side holes of the piece. If this work were done by hand, the production of the switches would be limited.

The engineering department of this molding plant set out to solve the problem of rapid production in a manner which would permit the continued use of a hand-type mold. The final decision rested on the use of a transfer mold which had a removable yoke or pin plate—the pins to be employed as supports for the inserts during the molding operation. The arrangement then was altered to include an ingenious hydraulically operated fixture for the dismantling of the mold. This device is shown in Fig. 4. As can be seen, this fixture employs three hydraulic cylinders. The one at the bottom serves to remove the bottom plate from the mold; those at the side withdraw the core pins. After the removal of these pins, a wedge mechanism located at the top of the device is activated. This movement releases the knockout pins which, in turn, eject the pieces from the mold. The lettering on the illustration corresponds to that shown on Figs. 2 and 3. *B* is the lower fork of the fixture which here is ready to receive the base plate that supports the mold. The side hooks (*A*) serve to grasp the bars which hold the core pins while the wedges (*D*) hold knockout pins (*C*). (*Please turn to next page*)

1



1—Three threaded inserts that are molded vertically and two horizontal molded-through holes, all integral parts of this small electrical contact switch housing, combine to complicate the molding of the phenolic case

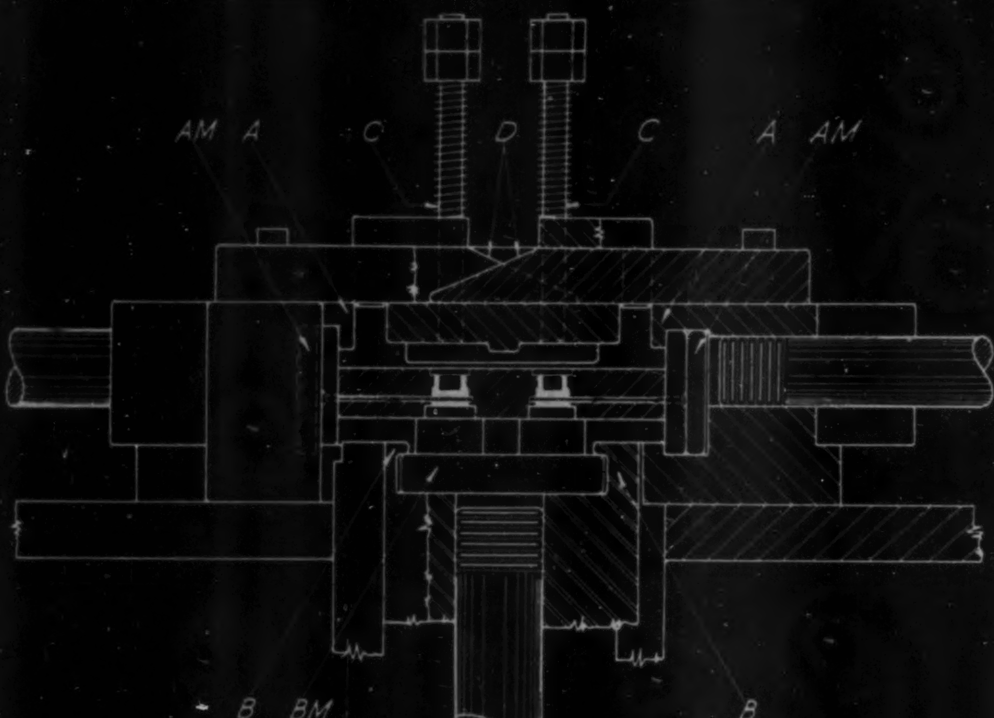


FIG. 2

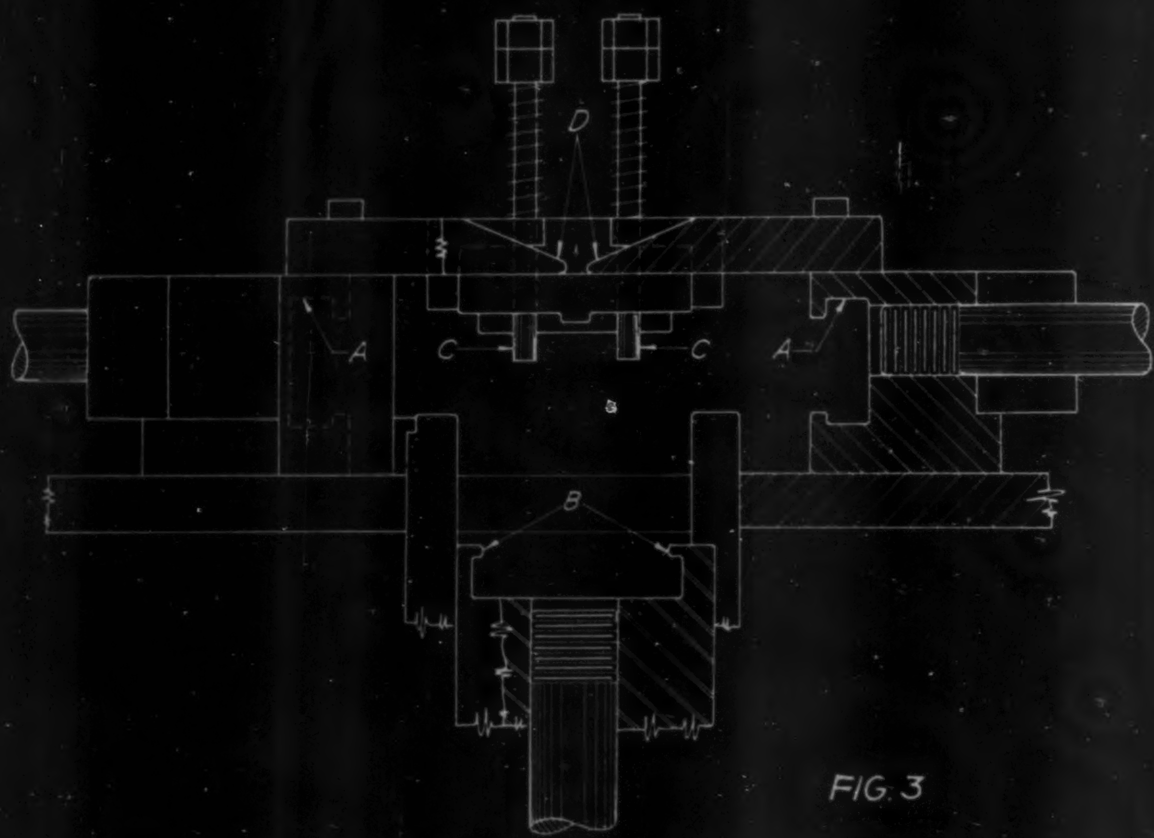


FIG. 3

ALL DRAWINGS COURTESY CHICAGO MOLDED PRODUCTS CO.

2—In this cross section, the dismantling fixture is shown in a closed position with the mold in place. The molded switch cases can be seen at the center of the drawing. The various working parts of the unit are: B, the lower fork; BM, the base plate of the mold; A, the side hooks; AM, the bars holding the core pins; C, the knock-out pins; and D, the wedges. 3—A side view of the fixture in an open position with the mold removed

The blueprint shown in Fig. 2 represents a cross section of this fixture when it is in a closed position with the mold in place just as it comes from the press. The lower fork (*B*) of the fixture grasps the base plate of the mold (*BM*). The moving of the control lever actuates the lower hydraulic cylinder attached to fork (*B*), thereby stripping the base plate from the mold. This plate then is removed from the fixture leaving ample space for the molded parts when they are knocked out of the cavities. The next operation involves the turning of a second valve handle which operates the two side cylinders. These cylinders withdraw the hooks (*A*) which grasp the bars (*AM*) on which the sliding core pins are mounted. Approximately half the motion of the two side cylinders is needed to withdraw the sliding core pins. The balance of this same action slides the wedges (*D*) outward, thereby permitting the knockout pins (*C*) to lower under spring tension. This action serves to eject the molded parts into the space previously mentioned. The parts then are removed, the side cylinder and core pins are returned to their original position and the base plate is reinserted in the fixture. In other words, the entire mold is reassembled by a complete reversal of the motions described above.

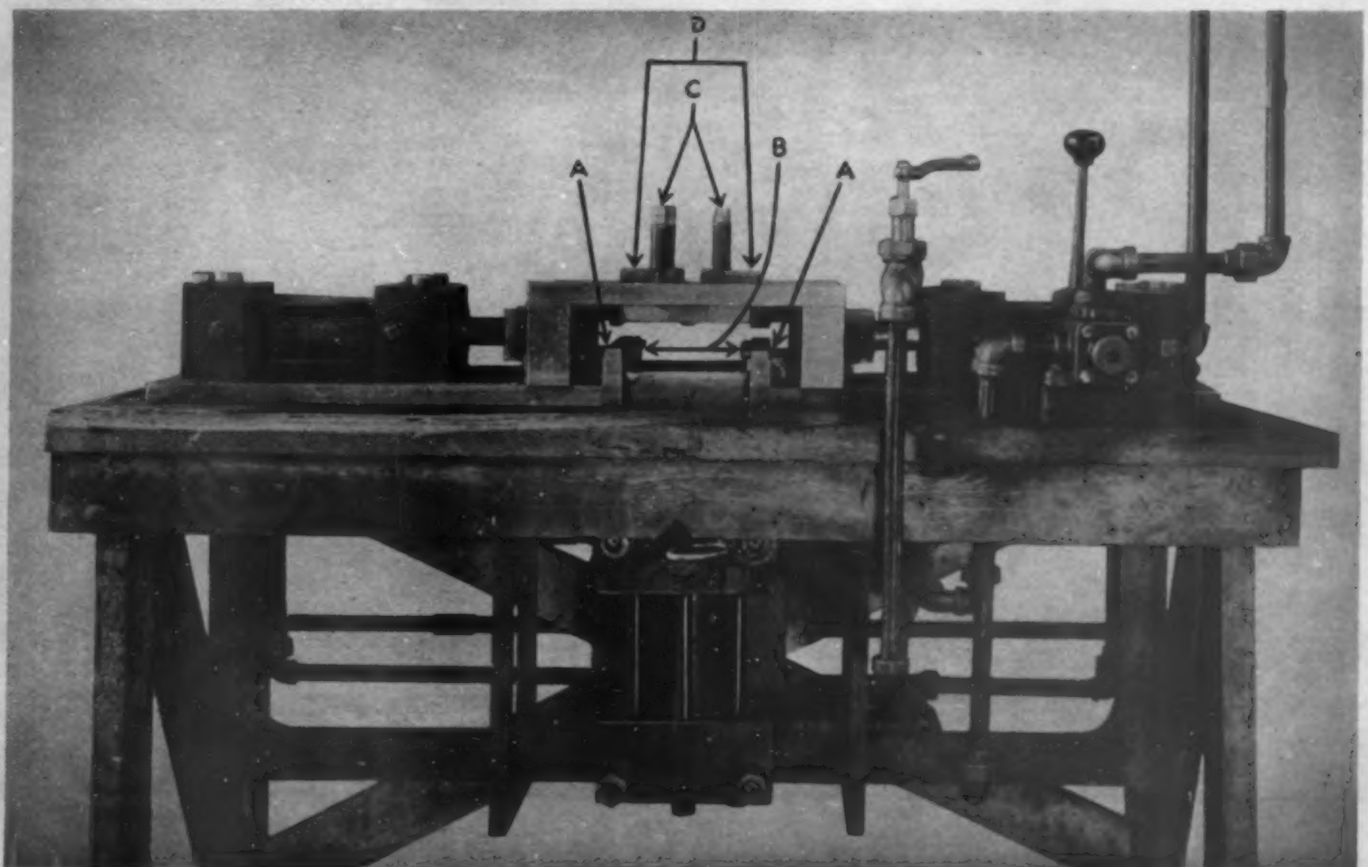
Figure 3 shows the disassembling fixture in an open position with the mold removed. This cross-section gives a clearer conception of the construction of the hooks (*A*) which grasp the mold bars upon which the core pins are mounted. Of similar design is the fork (*B*) which holds the base plate of the unit in its proper position prior to disassembly. The wedges (*D*) have been moved back by the same mechanism that activates the side hooks (*A*), and the knockout pins (*C*) have dropped down to a position where they would eject the molded pieces were the mold in place. While a description of this disassembly fixture may make the procedure sound long, it really is very quick. After the mold has been transferred from the press to this new machine, it is but a matter of seconds before the molded parts have been ejected from the mold. Almost immediately the fixture is ready for the next disassembly job. Placed in the midst of a group of presses, the unit is capable of handling the molds from all of the machines.

Production of switch housings from a 6-cavity hand mold increased so markedly as a result of the installation of this fixture that the molding plant has decided to investigate further the possibilities of this type of disassembly operation. The company is considering the use of a fixture of this type for all molding jobs that are designed for production in an automatic mold and that call for a complex cam operation. They also are giving thought to its use in molds that are operated by hand and that employ loose mold parts and side pulls. Adaption of this disassembly fixture to these various types of molding operations would reduce production time materially and greatly simplify the work.

Credit—Material: Bakelite. Molded by the Chicago Molded Products Co.

4—A removable yoke and a hydraulically operated dismantling fixture are employed in the transfer molding of the phenolic housing of the Micro switch. Three hydraulic cylinders are required for the operation of this latter device. The bottom cylinder which extends below the level of the table top, removes the bottom plate from the mold. The cylinders at either side of the mold, withdraw the core pins and actuate a wedge mechanism which releases knockout pins. Lettering on this illustration corresponds to that used on the blueprints

PHOTO, COURTESY CHICAGO MOLDED PRODUCTS CO.



PHOTO, COURTESY EMPIRE ELECTRIC BRAKE CO.

1—The end of a lever arm, gripped in the jaws of a soldering tool, is being heated prior to assembly with a cellulose acetate knob. As can be seen, the heating unit is held in a fixed position by a small metal brace

New plastic-metal assembly method

WITH the production lines of all industries moving at top speed, it is incumbent upon all transportation facilities to operate with 100 percent efficiency in keeping end products moving from the factory to the point of use. To the trucking industry this means a minimum of repairs to old equipment and a speed-up in the delivery of new trucks and trailers. Contributing to this effort to get both military and commercial trucks on the road and keep them there, is a new method of permanently assembling a plastic knob to the lever arm of the controller.

One of the ingenious American methods of making fewer transportation units carry a greater tonnage, has been the use of the so-called tractor and trailer truck system. With the use of such equipment, the carrier is on the road practically all the time. The driver need only back his detachable trailer to the unloading platform, uncouple and hook up to a loaded unit. Then he again is ready for the road.

In this coupling and uncoupling process, the speed and certainty with which the brake power connection can be handled is a major factor not only in the speed of the operation but in the safety and sureness of performance. For the operation of the electric brakes which are installed on these trailers, a hand-operated controller is mounted on the steering column of the prime mover. The lever usually is placed on the left side of the steering post—a position best suited to the convenience of the driver. Brake application is accomplished by actuating a handle which provides a finely graduated control. This lever is equipped with a plastic knob of a type similar to those used on the gear shifts of late models of automobiles.

The cellulose acetate knob shown in Fig. 2, was designed with no threads and with an inside diameter of $^7/_{16}$ inch. Theoretically this made the piece a press fit on the $^7/_{16}$-in. diameter section of the operating lever. A sectional view of the lever and knob are shown in Fig. 3. The thread method of assembly was eliminated because of the need for reducing the machining operations not only on the knob but on the metal lever as well. Another reason for the abandonment of the threaded parts was a tendency on the part of the knob to come unscrewed.

It was the desire of the company manufacturing the brakes on which these knobs are used, to assemble these plastic parts merely by driving them home on the shaft. Due to variation in the diameters of the operating lever as well as to slight discrepancies in the knob, great difficulty was encountered in this operation. Many knobs when assembled on oversized shafts, cracked and had to be discarded. More knobs were thrown away when the knobs were a loose fit. As a matter of fact, the rejection count was so high—over 10 percent—that it could hardly be called an operation. A similar difficulty was experienced by a large automobile manufacturer when an attempt was made to assemble a similar knob to a metal shank of a gear shift lever on which a sharp straight knurl was machined. Theoretically this knurl was supposed to cut its way into the assembly hole of the knob to make a permanent and shake-proof unit. In practice this method did not work out and even to this day plastic knobs that are assembled in this manner are cracking despite the fact that they are heated before assembly.

The procedure finally adopted for the assembly of these knobs and levers has proved so successful that the number of rejects has been reduced to one-half of one percent. The first step undertaken at the Empire Electric Brake Co., is the heating of the end of the handle. Then the knob is pushed into place. As the production assembly at this plant was arranged so that the completed controller was painted before installation of the knob, ordinary means of heating the handle, such as over an open flame, could hardly be considered. Such

a procedure probably would damage the paint finish.

The problem of preserving the paint during the heating operation was solved by the installation of a "thermo-grip" soldering tool. This unit comprises a plier-type tool attached to a power unit. It operates on a resistance heating principle and has easily detachable carbon ends which permit the use of specially shaped carbons to meet the needs of particular jobs. The power unit has a "hi-lo" switch which provides two heats, the low heat being 15 percent below the maximum. Plier-type jaws with three-position openings are used in this tool to insure uniform heating of the metal parts which are placed between them. This construction allows the carbon to contact the metal at two places, an impossibility if the jaws were operated on a scissor-type principle. All current carrying parts are carefully insulated. Not only are the handles designed to protect the operator from shock, but the two jaws are insulated from each other.

The extreme end of the trailer control handle—about $1\frac{3}{16}$ in. of the metal is left unpainted—is heated by insertion between the carbon jaws of the soldering tool (Fig. 1). Since the steel handle completes the circuit in the unit, it heats rapidly by conduction to the required temperature. Approximately 3 sec. is required for this operation. Then the knob is pushed firmly on the handle and dipped immediately into a container filled with water. When the heated lever arm is inserted in the open shank of the plastic knob, the plastic material melts slightly and becomes sticky. This causes it to adhere to the metal. The bond solidifies into a permanent union when the assembly is dropped into cold water. The rapid cooling also prevents distortion of the knob. According to H. L. Niles, production manager, "tests have proved that the plastic material in the knob is physically and permanently attached to the metal of the control handle."

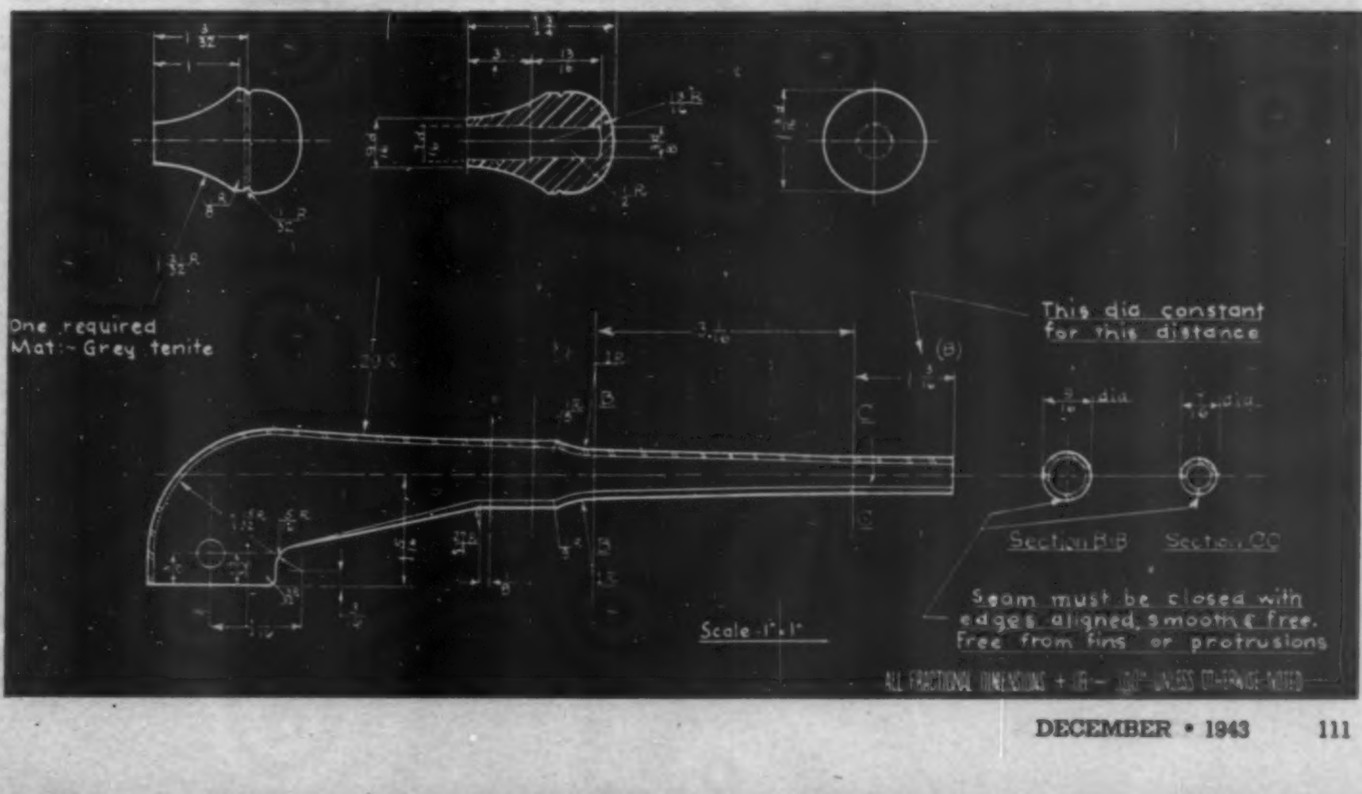
One of the more important advantages of this method of assembly is the wide tolerance permitted in the manufacture of the handle. Even if it is overside, this process will allow the knob to conform to the handle after heating. Not only is knob breakage negligible when this method is employed, but the plastic piece becomes so firmly attached that it can be removed only by destruction of the knob itself. This development is not limited to hand controlled levers—knobs may be installed on any metal shaft—and these "thermo-grip" soldering tools can be mounted in assembly lines. Savings in materials and machining have reduced unit cost, and the method has proved to be a simple one to adopt. This method of heating also can be used for inserts in thermoplastic materials when the molding-in of inserts causes a marked slowdown in production.

Credits—Material: Knob, Tenite. "Thermogrip" tool manufactured by Ideal Commutator Dresser Co.

2

2—Hand-controlled lever arm and cellulose acetate knob before and after assembly. The tip of the lever which is subject to heating is left unpainted. 3—A sectional view of the lever and knob. The dimensions indicate that the plastic part is, in theory, a press fit on the metal lever

3 DRAWING, COURTESY EMPIRE ELECTRIC BRAKE CO.



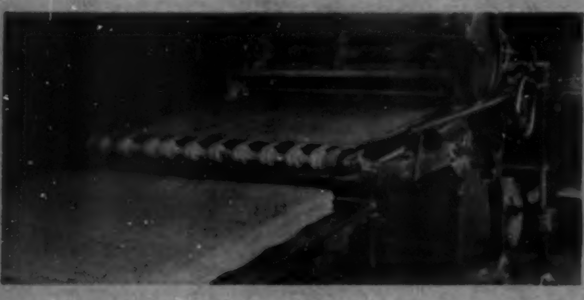
Life On The

MELMAC LAMINATING RESINS OFFER ADVANTAGES IN ELECTRICAL FIELD

Essential parts for "LAMICOID" instrument dials, panels, nameplates are being made from MELMAC* laminated sheets because of the high dielectric strength, surface hardness, high heat resistance, color stability and non-inflammability imparted by the MELMAC resin. Steps in the manufacture of these laminates as produced by the Mica Insulator Company in both rigid and flexible types are shown here. The MELMAC laminating resins include a range for the production of extremely hard to very flexible combinations. Further information on these and other Cyanamid laminating resins, LAMINAC* and MELURAC*, will be supplied on request.

(Above) **TYPICAL PARTS** fabricated from plastic laminated sheets are these fluorescent dials, nameplates, wiring diagrams and panels made by Mica Insulator Company.

(Above) **1. A PAPER FILLER** is passed through an impregnation tank to be coated with the resin, then into drying oven.



(Above) **2. IMPREGNATED ROLLS** are cut on sheeting machine to desired size for final panel, usually 36" x 42".

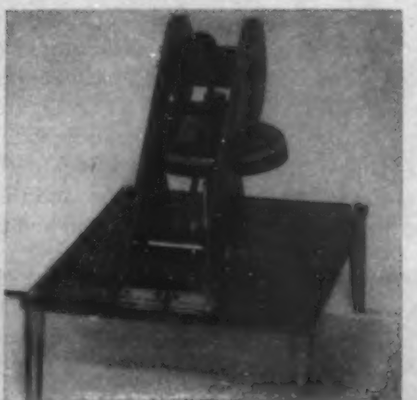
(Above) **3. ASSEMBLED INTO SETS,** the number of sheets is controlled by the weight and thickness desired and varying resin content by use.

(Above) **4. PLACED BETWEEN STEEL PLATES,** laminated sheets are cured with heat and pressure in hydraulic press, ready for fabrication into parts.

Plastics Newsfront

(Right) **NEW MANUAL ON MELMAC MOLDING COMPOUNDS** is now available to designers, engineers, and others interested in the fabrication and use of plastics. It contains a complete summary of the latest information and technical data on the various MELMAC molding materials currently available. There are sections on the properties and molding characteristics of the three forms of MELMAC, alpha-cellulose-filled, mineral-filled, and chopped-cotton-fabric-filled. Other Cyanamid plastics and resins are also described. Complete tables of properties, charts for preform sizes, cure rates, temperature and pressure, instructions for molding methods, design, and applications are given. A request on your business letterhead will bring you your personal copy of this useful and informative booklet.

(Below) **BUTTONS MOLDED OF BEETLE*** are being used on the uniforms of all branches of America's, as well as other Allied fighting units. For the WAC uniform this versatile material, gives smooth, attractive and serviceable buttons that stand up under laundering, ironing, dry-cleaning. The shank of the button (shown in insert) is molded right in position in a single operation—helping to speed production and cut cost.



(Above) **NEW ARC RESISTANCE TEST** to detect areas of low arc resistance in sample plastic moldings has been developed in the Cyanamid Research Laboratories to supplement the standard A.S.T.M. test. With increased severity over a large area, it reveals with greater accuracy and speed, materials which contain areas of potential premature breakdowns. In the photo at left above, a test sample is shown on the "turntable" of the Rotary Arc Tester. Photo at right above shows how electrodes are brought in close contact at the rim of the test piece to check possibility of electrical breakdown. Additional information on apparatus and test procedure will be sent on request.

*Reg. U. S. Pat. Off.

AMERICAN CYANAMID COMPANY

PLASTICS DIVISION

30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

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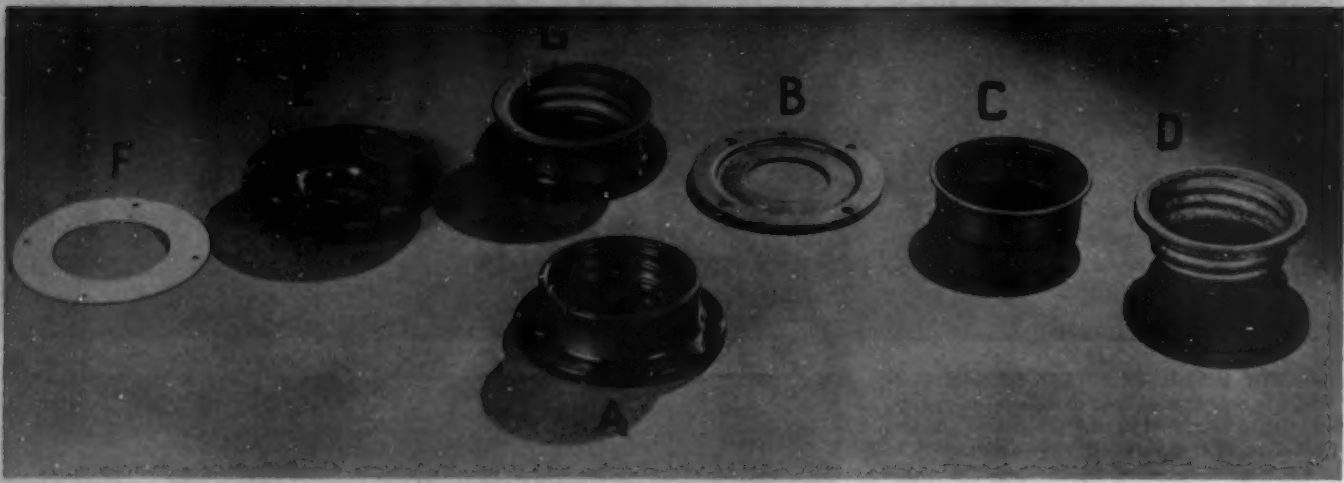


1—The phenolic lighting fixture collar (A) which can be seen in the foreground, replaces the 5 separate pieces that are indicated by the letters B, C, D, E and F. The unit, G, is an assembly of the parts B, C and D

Case history of a plastic conversion

DURING the past two or three years the plastic industry has been besieged with requests for new molds that would permit the replacement of metal with so-called "non-strategic" plastics materials. This "non-strategic" qualification has been one of the biggest fallacies which has risen to plague the molding industry. Today plastic materials are at least as critical, if not more so, than many of the materials which they have replaced. Because of this fact the War Production Board during the past six months has not permitted any so-called "conversion" jobs in plastics unless it was proved beyond a shadow of a doubt that the change was made not to conserve metal, but to better the product or to conserve what have become America's most strategic items—man and machine hours.

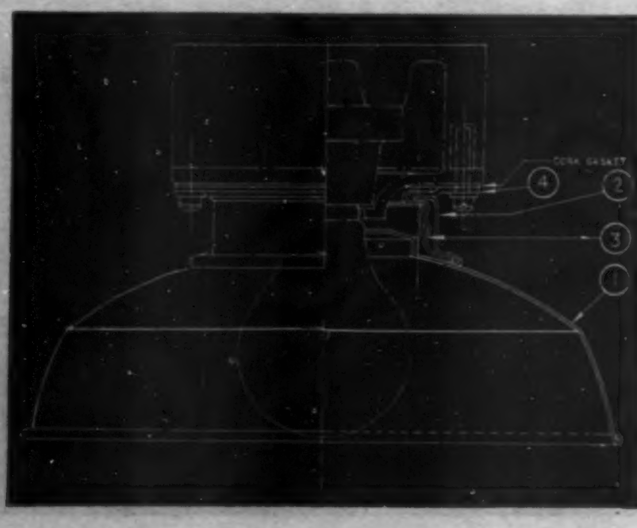
Against this background, the Bureau of Ships of the U. S. Navy Department has approved the conversion to plastic of a lighting fixture collar which is an adapter between a ceiling fixture and a reflector. In this application (Fig. 1) one high-impact phenolic unit (*A*) replaces a total of five separate parts—one of which was made of phenolic (*E*), one of cork (*F*) and three of metal (*B, C, D*) which are the component parts of the assembly (*G*). One of these metal parts employed vitreous enamel iron which is found on the highly critical list. For the information of members of the plastic industry as well as of contractors currently manufacturing parts for the Bureau of Ships, a brief résumé is given of the steps which were followed from the time of the inception of the idea until its official approval for production by the Electrical Design Division of the Bureau of Ships.

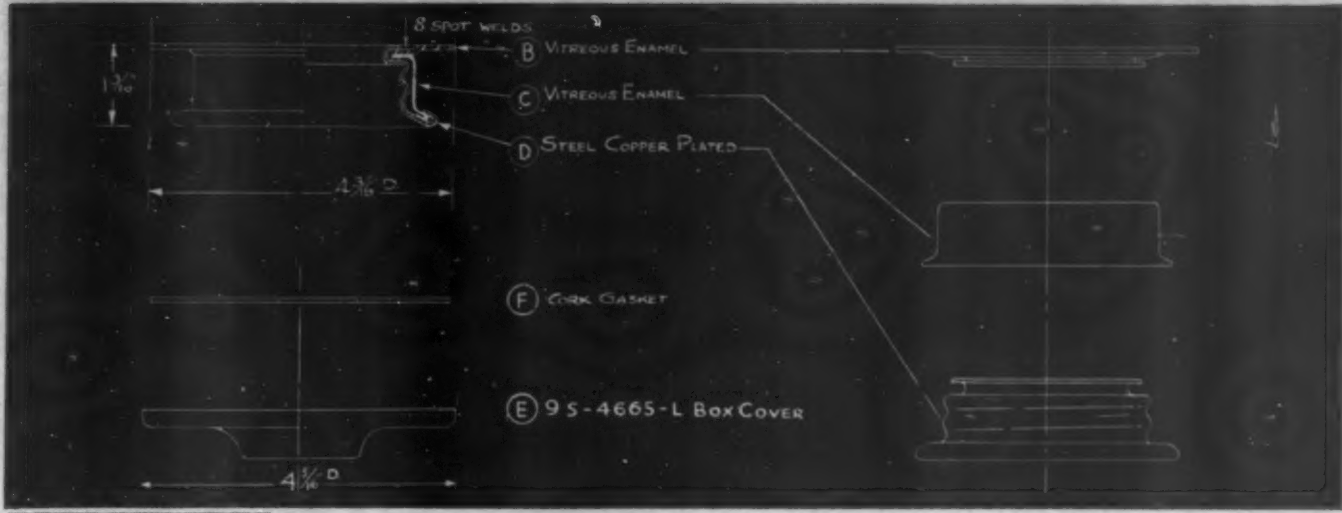
The Lightolier Co., a peacetime manufacturer of home lighting fixtures, has converted practically its entire production to the manufacture of lighting equipment for the Army and the Navy. Having become familiar with the production and assembly of the various types of standard Navy

2—A new lighting fixture with plastic shade, one-piece combination thread sleeve and junction box cover.
3—Cut-away view of a complete lighting fixture before conversion to plastics. The unit includes: shade (1), cork gasket, and 3 metal parts (2, 3 and 4) which, in the new assembly, are replaced by a one-piece collar

2

3





ALL DRAWINGS, COURTESY LIGHTOLIER CO

4—Five parts (B, C, D, E and F) comprised the former collar. The 2 vitreous enamel pieces (B and C) and the steel copper-plated part (D), shown separated at right, were assembled to make one unit as shown at left

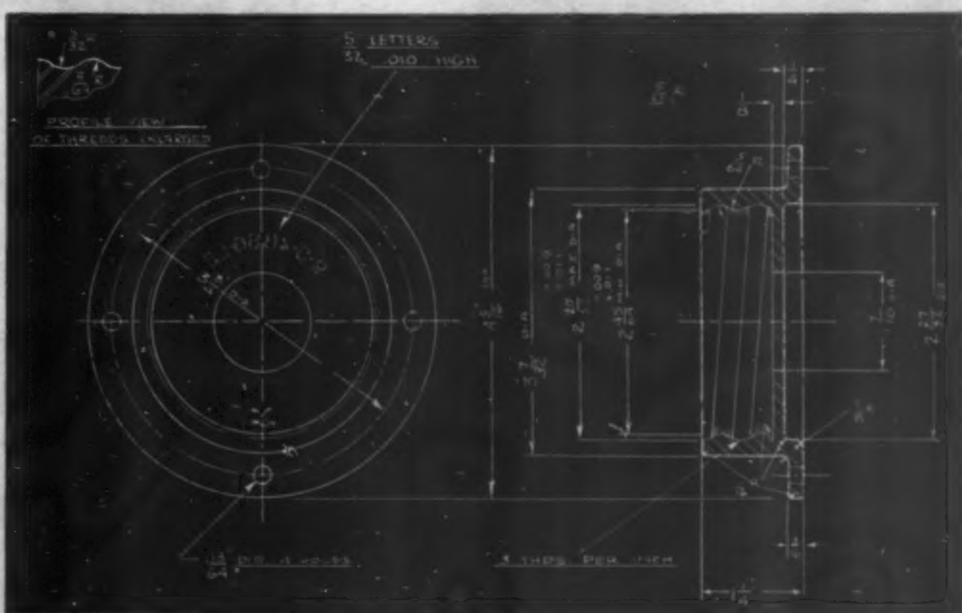
lighting fixtures through work on several contracts, Vice-president Jacob H. Blitzer became convinced that there were at least a few parts in standard ceiling fixtures as shown on U. S. Navy Bureau of Ships assembly drawings, 9-5-4665-L Type VIII-MRI, 9-5-4665-L Type VIII-MRII, 9-5-4917-L Type VIII-MRI-V and 9-5-4902-L Type VIII-MRIII, which could be converted to plastics at a great saving in weight and in man- and machine-hours. After extended discussions with a large eastern molder it was decided that one part—a combination cover and threaded collar—could be designed as a satisfactory replacement for the five parts then in use in the standard assembly.

After completion of the design for this collar, orders were placed for a single-cavity experimental mold. In running samples from this mold, several different curing times were used with Navy Specification high-impact material known as C.F.I.-20 on Specification 17-P-4. One of the tests which equipment of this type must pass is known as the Type H. I. Shock Test. Standard equipment for handling this test is available at several Navy Yards as well as some private testing laboratories. Roughly, the testing device consists of a massive framework on which is mounted a large anvil. Suspended from the upper portion of this frame is a heavy pendulum with a hammer mounted on its lower end.

While hammers of various weights can be employed for this particular test, a hammer weighing 400 lb. was used. The hammer is lifted by means of a small electric hoist to a position which will permit it to drop through an arc of 5 ft. from the point of release to the point of impact with the back of the anvil. The complete test consists of two drops of the 400-lb. weight swinging through an arc of 5 ft. and impinging upon the top edge of the anvil. If after receiving these terrific shocks twice in each of the three specified directions, no defects can be found in the plastic parts, they are accepted for production. Unofficial shock tests first were run on the plastic samples since it was felt that no parts should be submitted to the Navy for formal test until all "bugs" had been eliminated, a method of procedure to be highly recommended.

On September 15, 1943, the Electrical Design Division of the Bureau of Ships received the following request: "We respectfully request the authorization to substitute phenolic material, U. S. Navy Specification 17-P-4-C.F.I.-20, on threaded collar, 9-S-4866-L-2, in place of 9-S-4866-L-2-3-4." Inasmuch as any request for (*Please turn to page 168*)

5—Top and sectional view of one-piece combination thread sleeve and junction box cover assembly. The unit replaces the parts marked B, C, D, E and F in Figs. 1 and 4



Pulp preforming and molding

by S. H. A. YOUNG* and RICHARD J. BOX†

IN the plastics industry resin-fiber molding or pulp molding has received considerable attention in recent months. The most common questions asked about resin-fiber molding are: Where does it fit into the present plastic picture? What equipment is required? And what are the approximate costs?

In its essential steps the resin-fiber, or pulp molding process, involves felting a fiber preform, incorporating a thermosetting resin into the preform, removing volatile matter and molding the resulting resin-fiber preform under heat and pressure. Resin may be incorporated in the beater either as discrete particles which are trapped among the fibers in felting or as a solution of sufficiently high concentration to leave the desired amount of resin deposited on the fibers after felting and drying. The resin may be incorporated by impregnation subsequent to felting and drying. The resulting products are comparable in appearance and water resistance to ordinary compression moldings.

The resin-fiber process answers two hitherto unsolved problems in the plastics industry: 1) It provides a method for making high-strength contoured plastic articles of relatively thin and uniform cross-section thickness such as radio loud speaker diaphragms. 2) It provides a method for producing relatively large articles of considerable contour and uniform section thickness such as refrigerator panels and aircraft fairings. Resin-fiber molding may be competitive in borderline cases with powder molding and with laminate molding. However, in general, it promises to extend fields of application for plastics rather than compete in present fields.

Basically, the resin-fiber process is not generally applicable to the production of the relatively small parts which constitute the bulk of the molded plastic articles manufactured today. Rather, it is suited to the production of relatively large articles which have complex forms and which have relatively uniform cross-section thicknesses. As to color in resin-fiber products, a range approximating that of present-day phenolic molding compounds is obtainable. At present, for the lighter colors, a baked on finish is usually required. However, a promising modification of the process is being developed with a view to producing solid light color moldings.

The principal items of standard equipment required for resin-fiber molding are: 1) pulp preparation equipment such as papermill-type beaters or breakers, 2) vacuum felting equipment, 3) drying equipment, 4) impregnating equipment (if the resin is incorporated in the fiber by impregnation), and 5) molding equipment. Special tools or dies required for each item produced include felting tools, drying forms and molding dies. Large quantity production of small items such as speaker diaphragms, is adaptable to fully automatic equipment. For relatively large articles such as cabinets and aircraft parts, semi-automatic equipment appears to be more feasible and is considerably more flexible in operation.

The question of tools is always an important one. In the production of resin-fiber products, certain deviations from conventional practice are recommended in order to obtain optimum results. A ventilated preforming tool ordinarily made of bronze or similar metal (*Please turn to page 166*)

* Technical Director, Hawley Products Co.
† Research Engineer, Hawley Products Co.

1—These disc springs with their large center holes are formed by the resin-fiber, or pulp molding, process

PHOTO, COURTESY HAWLEY PRODUCTS CO.

TECHNICAL SECTION

Technical Editor
DR. GORDON M. KLINE

Relation between repeated impact and fatigue tests*

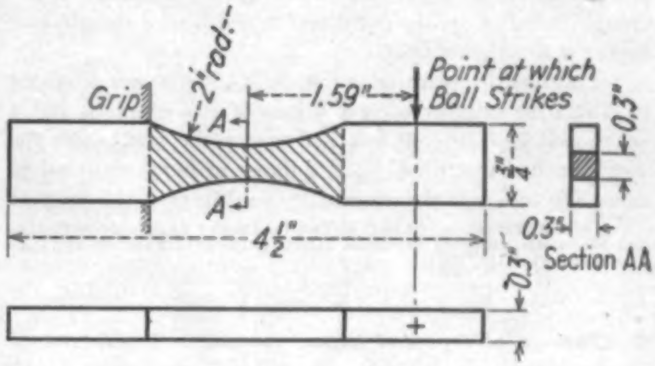
By WILLIAM N. FINDLEY[1] and OTTO E. HINTZ, JR.[2]

THE tests reported in this paper were made to determine the effect of repeated-blow impact loading on cellulose acetate, and to evaluate this effect in terms of the fatigue properties of the material. This project was undertaken because there are many instances of repeated impact loading which occur in service. The effect on plastics of repeated impacts has been studied by several investigators[3, 4, 5] as has the general subject of repeated impact on materials.[6] Some of these investigators found that failures occur in plastics after a number of repetitions of bending impact in which the energy delivered to the specimen per blow was less than 10 percent of the energy required to fracture the specimen in a single blow. Some investigators concluded that a limiting value of energy was reached after about 100 to 300 blows, below which value fracture would not occur even with an indefinitely large number of blows.

In order to study the relation between repeated impact tests and fatigue tests a shape of specimen was chosen which would allow calculation of the stress at the point at which fracture started. Both repeated impact tests and fatigue tests were performed with this specimen, and the stress and number of cycles for fracture were determined for each type of test.

Material and specimens

The cellulose acetate plastic used for these tests was a clear, transparent thermoplastic composed of medium-viscosity cellulose acetate of the acetone-soluble type, plasticized with about 26 percent of phthalate and aromatic phosphate ester plasticizers. This formulation is the same except for a slight change in plasticizer, as that for which test results were reported in three previous papers by the senior author.[7, 8, 9] All specimens used in these tests were cut from the same sheet of cellulose acetate plastic. The sheet was 0.3 in. thick and was made by the sheeter process at a molding temperature between 200 and 250° F. The finished sheet contained less than one percent of residual solvent and water.



1—A cross-section of specimen used in these tests

The specimen used is shown in Fig. 1. The bending impact and fatigue specimens were formed by sawing rectangular blocks from the sheet and milling the sides and the reduced section. During all machining operations care was used to avoid heating the specimens as this might change the properties. All machining was done in a room maintained at a constant temperature of 77° F. and constant relative humidity of 50 percent. This was done to avoid exposing the material, which had been in the laboratory for about two months, to a different atmosphere. All tests were also conducted in this same room. All specimens were hand polished over the reduced section to give a uniformly smooth surface so as to avoid stress concentration. Three grades of paper, numbers, 0, 00 and 000, were used successively, and polishing was done slowly enough to avoid heating.

Machines and methods of testing

Repeated impact machine.—The impact test was performed by causing a steel ball to fall from a fixed height and strike the end of a specimen mounted as a cantilever beam. The height of drop used in this series of tests was 22.6 inches. This height produced a velocity at the time the ball struck

* This paper was presented at the 1943 Annual Meeting of the American Society for Testing Materials, in Pittsburgh, Pa., and is published here by permission of that Society.

[1] Associate in Theoretical and Applied Mechanics, College of Engineering, University of Illinois.

[2] Radio Corporation of America; formerly student in the College of Engineering, University of Illinois.

[3] R. Burns and R. W. Blackmore, "Impact Fatigue Endurance Limit of Plastics," Experimental Records of Bell Telephone Laboratories, Inc., received by W. N. Findley in private communication with the author, 1942.

[4] L. H. Callendar, "New Methods for Mechanical Testing of Plastics," British Plastics *13*, 445 (April 1942); 506 (May 1942).

[5] Report of Committee D-9 on Electrical Insulating Materials, Proceedings, Am. Soc. Testing Mats. *33*, 399 (1933).

[6] S. Timoshenko and J. M. Lessels, "Applied Elasticity," Westinghouse Technical Night School Press 434 (1925).

[7] William N. Findley, "Mechanical Tests of Cellulose Acetate," Proceedings, Am. Soc. Testing Mats. *41*, 1231 (1941).

[8] William N. Findley, "Mechanical Tests of Cellulose Acetate—Part II on Creep," Proceedings, Am. Soc. Testing Mats. *42*, 914 (1942).

[9] William N. Findley, "Mechanical Tests of Cellulose Acetate, Part III," Transactions, Am. Soc. Mechanical Engrs. *65*, 479 (1943); MODERN PLASTICS *20*, 99 (May 1943).

the specimen of 11.0 ft. per sec. (the striking velocity used in the "standard" impact test).[10] Tests which required less than 1000 blows to cause fracture of the specimens were performed by hand. When a larger number of blows was required, apparatus was provided to repeat the blows automatically at a rate of approximately 100 blows per minute.

The equipment used for the repeated impact tests is shown in Fig. 2. The specimen (*A* in Fig. 2) is clamped as shown in Fig. 3, to a heavy steel rail imbedded in a concrete block. This massive support was used in order to reduce to a minimum the energy adsorbed in deflection of the support.

Steel balls were caused to roll off the end of a trough having a gentle incline (*B*, Fig. 2). The trough was adjusted by sliding forward or back to the position which would cause the falling ball to strike at the center of the flat top face of the specimen (see Fig. 3). When the apparatus was operated by hand the ball was caught on rebound from the specimen and returned to the trough *B* by hand. For automatic operation several balls were used, and a motor-driven elevator was provided to return the balls to the trough *B* from which they fell. This elevator consisted of a large wheel (*C*, Fig. 2) containing several pockets spaced around its periphery. The wheel was driven at slow speed by a motor. As each pocket *D* passed the hopper *E* containing the balls to be returned, a ball entered the pocket and was carried up by the wheel and discharged at *F*. From this point the ball entered the trough *B*, rolled slowly down to the end of the trough, and repeated the impact operation.

For automatic operation, a counter (*G*, Fig. 2) was provided to count the number of revolutions of the wheel *C*, and a micro-switch (*H*, Fig. 3) was used to stop the wheel when the specimen had fractured. The number of blows required to cause fracture was determined by multiplying the number of revolutions of the wheel by the number of pockets in the wheel. In conducting a test, a specimen was fixed in the machine and then repeatedly struck by the same size ball until fracture occurred. Another specimen was then placed in the machine and the operation repeated using a smaller size ball. Balls ranging in size from 2 in. to $^{13}/_{32}$ in. in diameter were used. The energy delivered per blow corresponding to the different size balls ranged from 25.4 to 0.70 in.lb., respectively.

Fatigue machine.—The fatigue tests were conducted on a fixed-cantilever, constant-amplitude fatigue machine. In this type of machine the specimen (*A*, Fig. 4) was repeatedly bent back and forth as a cantilever beam by the variable eccentric *B*.[11] The stress, σ, in the specimen (Fig. 1) at the minimum section was computed from the equation $\sigma = \frac{Mc}{I}$. The bending moment, *M*, was obtained by calibration of the specimen as a beam by means of dead weights. The deflection of the specimen under load was measured by means of a dial gage (*C*, Fig. 4). The number of cycles to which the specimen was subjected was recorded on a counter *D*; and a toggle switch, *E*, was arranged to stop the machine when the specimen fractured. Thus for each specimen placed in the machine the stress corresponding to the deflection of the specimen during the test was calculated from the bending moment measured while the machine was at rest, and the number of cycles for fracture was obtained.

Calculation of stress due to impact

From the principle of conservation of energy, derived from Newton's second law of motion, it is known that the potential energy (measured with respect to the bottom of the drop)

[10] A.S.T.M. Tentative Methods of Test for Impact Resistance of Plastics and Electrical Insulating Materials (D256–41T), 1942 Book of A.S.T.M. Standards, Part III, 1071.

[11] A.S.T.M. Tentative Method of Test for Repeated Flexural Stress (Fatigue) of Plastics (D671–42T), 1942 Book of A.S.T.M. Standards, Part III, 1251.

2—Close-up of repeated impact machine. *3—Details of specimen in impact machine can be seen in this illustration*

2

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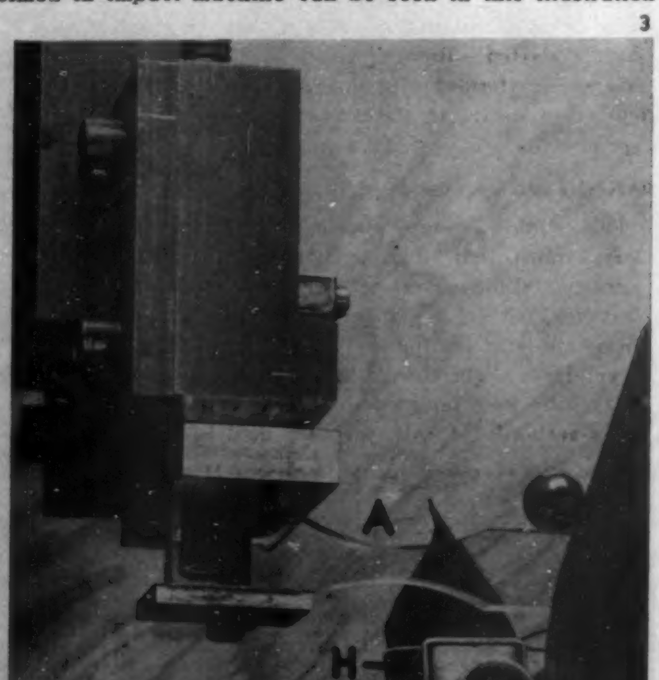


which the ball had at the start of the descent was equal to the maximum strain energy produced by the impact in the specimen and support, plus the energy dissipated in heat resulting from solid-friction and dry-friction. The potential energy of the ball was approximately equal to the product of the weight of the ball and the height of the end of the trough B (Fig. 2) above the surface of the specimen. Two other parts of the potential energy are small enough, compared to the total, to be neglected: 1) the potential energy equal to the product of the weight of the ball times the deflection of the specimen, and 2) the potential energy of the ball at the start of the descent with respect to the end of the trough. This part of the potential energy is transformed into kinetic energy of rotation and approximately horizontal translation due to the ball rolling down the inclined trough.

The maximum strain energy in the specimen occurs when the specimen reaches its maximum deflection. The strain energy may be expressed in terms of three components for this problem: strain energy of bending, strain energy of "horizontal" shear, and strain energy due to the localized compressive stress resulting from contact pressure between the ball and the specimen.

In order to evaluate the strain energy in bending and in shear in terms of the maximum contact force P, it was assumed that the distribution of strain (and stress) in the specimen, resulting from the impact, was the same as that which would result from a static load equal to P. This, of course, was not exactly true but does not involve serious error since most of the strain took place near the minimum section of the specimen. Calculation of the strain energy in bending and shear to a first approximation indicated that the strain energy in horizontal shear was negligible compared to that of bending. The amount of strain energy due to compression was also neglected because of the fact that stresses in compression were such that permanent deformation was not observed and the volume of material subjected to high stress under the contact was small compared to the volume of material subjected to high bending stresses.

The collision of the ball striking the specimen starts an elastic or sound wave which is propagated from the point of contact. This wave is reflected back and forth in the specimen in a complicated manner. The stress introduced in the specimen by this wave is probably not large except in the region of contact, and is probably reduced nearly to zero as a result of damping by the time the specimen has reached its maximum deflection. The elastic wave will have been reflected back and forth several times during the period required for maximum deflection of the specimen.

Thus, if the energy transformed into heat and the strain energy stored in small quantities in horizontal shear, compression, etc., are neglected, the maximum stress at the minimum section can be calculated by equating the product of the weight of ball and the height of drop, to the strain energy of bending in the portion of the specimen cross hatched in Fig. 1.

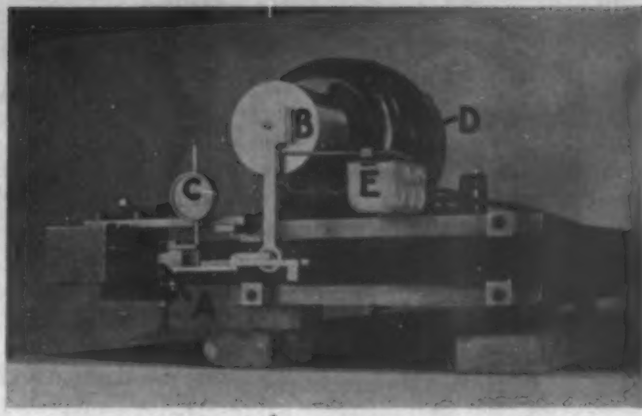
The strain energy of bending in a beam may be calculated from the equation[12]

$$U = \frac{1}{2}\int_0^l \frac{M^2 dx}{EI}$$

where

U = the energy in in.-lb.
M = the bending moment in in.-lb.

[12] See any advanced book on strength of materials.



4—*Fixed-cantilever, constant-amplitude fatigue machine*

E = the modulus of elasticity in p.s.i.
I = the moment of inertia of the cross-section in (in.)^4
x = the distance along the beam

In the impact specimen used, the moment of inertia I changes with x and can be expressed as an equation of the following form

$$I = a(b - \sqrt{-x^2 + cx + d})^3$$

where a, b, c and d are constants depending on the dimensions of the specimen. The bending moment M may be expressed in terms of the contact force of the ball as $M = P(x + e)$ where e defines the location of the point of contact of the ball. When these expressions were substituted in the equation for the strain energy, a rather complicated integral resulted:

$$U = \frac{P^2}{2Ea}\int_0^l \frac{(x + e)^2\,dx}{(b - \sqrt{-x^2 + cx + d})^3}$$

This integral was evaluated by the use of partial fractions and trigonometric substitutions. It then was possible to solve for the maximum contact force P in terms of the strain energy. Then, from the force P the maximum stress at the minimum section was computed using the flexure formula $\sigma = \frac{Mc}{I}$. The resulting equation was $\sigma_{max} = 4.34\sqrt{\frac{UE}{w}}$

where

E = the modulus of elasticity in p.s.i.
w = the width of the specimen, in (in.)
U = the strain energy in in.-lb. (which is replaced by the product of the weight of the ball times the height of fall)
4.34 = a dimensional constant

This constant applies only for a specimen of shape as shown in Fig. 1 when the point of contact of the ball is 1.59 in. from the minimum section of the specimen. Since the above equation involves the flexure formula, it does not apply accurately to cases in which stress is not proportional to strain as is the case when general yielding occurs. The modulus of elasticity of the material as determined from a tension test was 195,000 p.s.i. The above equation is not exact for the reasons discussed above and some others of lesser importance. It is believed, however, that the equation is sufficiently accurate to warrant the conclusions that are drawn on the following pages. (*Please turn to next page*)

The data from both the repeated impact and the fatigue tests are plotted in Fig. 5. In this figure the maximum stress of the cycle for both impact and fatigue tests is plotted against the log of the number of cycles for fracture. The open circles represent data obtained from repeated impact tests, and the filled circles represent data obtained from fatigue tests. A progressive fracture was observed to occur at the minimum section of the specimen. This type of fracture occurred in both repeated impact and fatigue tests, and the appearance of the fracture was substantially the same in both cases.

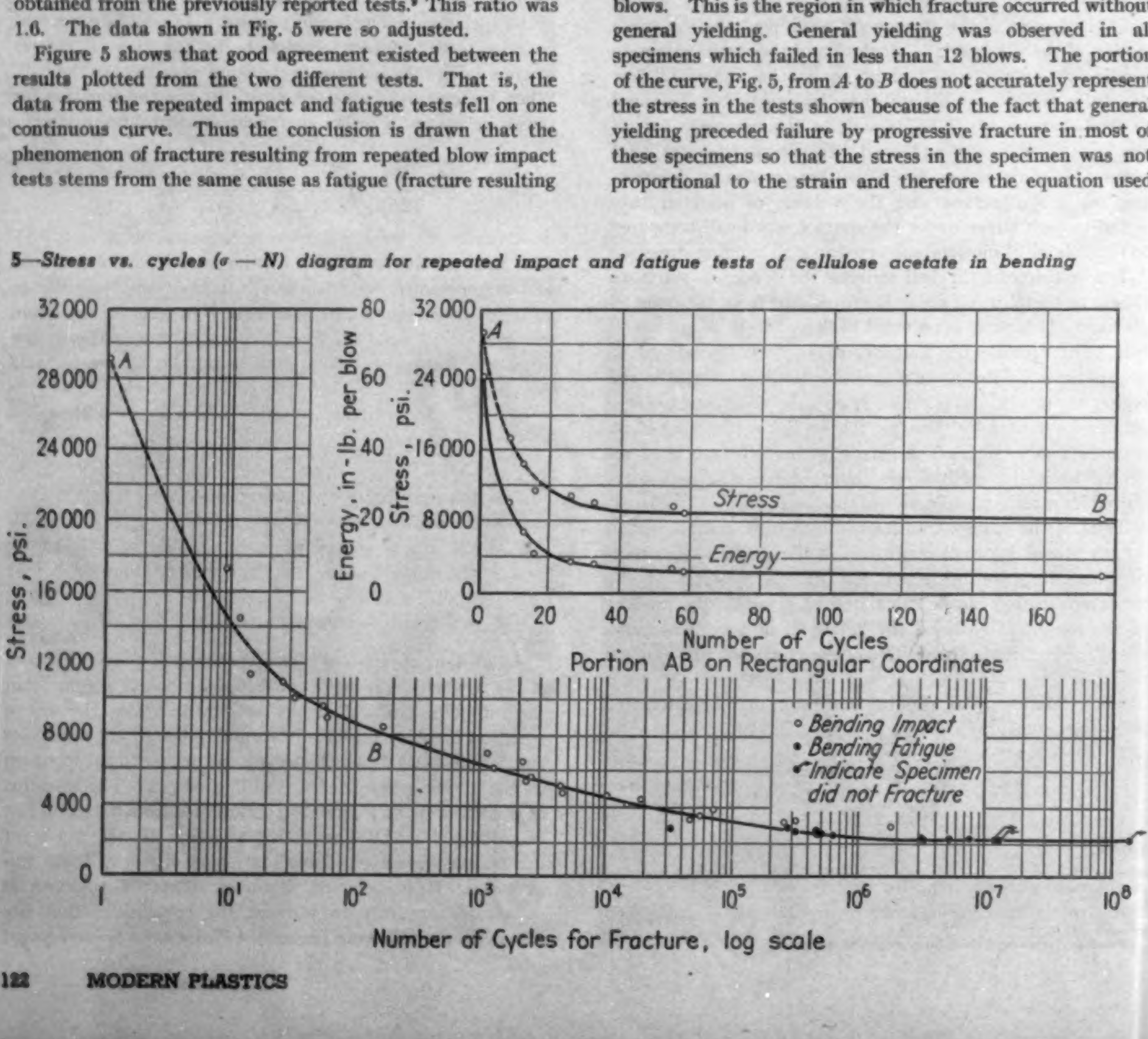
For the fatigue tests shown, the range of stress was a complete reversal. That is, the specimen was bent up and down equally in each direction. However, in the repeated impact tests the range of stress was from zero to a maximum. Thus it was necessary to take account of the effect of range of stress in order to compare the fatigue tests with repeated impact tests. Previous fatigue tests of cellulose acetate at different ranges of stress[9] showed the relationship between the range of stress and the endurance limit of the material. In order to compare the fatigue tests shown in Fig. 5 with the repeated impact tests, the fatigue test data we readjusted to correspond with a range of stress from zero to a maximum by multiplying the stress for each test by the ratio of the maximum stress of the cycle at the endurance limit for a range of stress from zero to a maximum, to the endurance limit for a completely reversed range of stress, obtained from the previously reported tests.[9] This ratio was 1.6. The data shown in Fig. 5 were so adjusted.

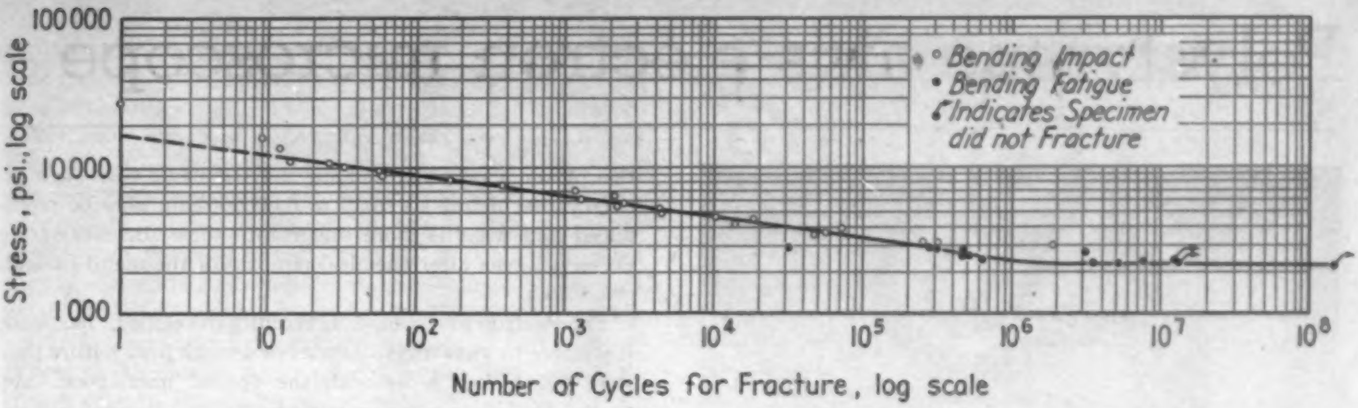
Figure 5 shows that good agreement existed between the results plotted from the two different tests. That is, the data from the repeated impact and fatigue tests fell on one continuous curve. Thus the conclusion is drawn that the phenomenon of fracture resulting from repeated blow impact tests stems from the same cause as fatigue (fracture resulting from a crack which begins and progresses under the action of repeated loading). The character of the fractured surface and the growth of the crack were observed to be essentially the same for both types of test.

Figure 5 shows that an endurance limit is reached at about one million cycles. This is evident from the fact that the curve becomes a horizontal line at one million cycles and remains horizontal out to about 200 million cycles (the duration of the tests). The diagram inserted in Fig. 5 represents the same data up to 180 cycles (*A* to *B* on the large curve) plotted on rectangular coordinates. Also shown is the energy-per-blow plotted against the number of cycles (or blows). Either of these 2 curves would lead one to believe that an endurance limit was approached after about 40 cycles. Comparison with the semi-log plot, however, shows that the endurance limit is not reached until about one million cycles or a stress about one fourth that indicated by the rectangular plot. The energy per blow corresponding to the endurance limit was 0.38 inch-pound. Comparing this with the energy required to fracture a specimen in a single blow, 61 in.-lb., it was found that the energy at the endurance limit was less than one percent of the single blow energy. (The single blow test was performed on a modified Izod impact machine because large balls were not available.)

Figure 6 shows the data of Fig. 5 plotted to a double-log scale. It was found when thus plotted that the data fell along a straight line from about 12 blows to one million blows. This is the region in which fracture occurred without general yielding. General yielding was observed in all specimens which failed in less than 12 blows. The portion of the curve, Fig. 5, from *A* to *B* does not accurately represent the stress in the tests shown because of the fact that general yielding preceded failure by progressive fracture in most of these specimens so that the stress in the specimen was not proportional to the strain and therefore the equation used

5—*Stress vs. cycles (σ — N) diagram for repeated impact and fatigue tests of cellulose acetate in bending*





6—Stress vs. cycles (σ — N) diagram for repeated impact and fatigue tests of specimen in bending, double log plot

in calculating the stress did not apply accurately.

The straight-line portion of the curve in which fracture occurred without general yielding can be represented by the following equation

$$\sigma = \frac{17{,}000}{N^{0.143}}$$

where N is the number of cycles for fracture and σ the maximum stress of the cycle whose range is from zero to a maximum. The equation is good only for values of bending stress σ between 2160 p.s.i. (the maximum stress at the endurance limit) and 11,000 p.s.i. and provided the temperature remains low enough that failure does not occur due to overheating, and provided also that the rate of strain is high enough to prevent general yielding from occurring at stresses lower than 11,000 pounds per square inch. The static tensile strength of this material was 4000 p.s.i. at a rate of strain of 0.012 in. per in. per minute.

Data were not obtained for fatigue tests at stresses higher than those shown because the heat which developed in the specimen due to internal friction at stresses well above the endurance limit caused failure by softening resulting from overheating rather than a failure by progressive fracture, so that higher stresses could not be used in the fatigue tests.

The time interval between impacts in the repeated impact test was long enough so that heating did not result. However, a temperature rise was observed in all fatigue tests. This rise in temperature was from 10 to 100° F. depending on the stress used. Correction of the fatigue data for rise in temperature would make for even better agreement between the two types of tests since an increase in endurance limit with reduction in temperature was observed with cellulose acetate.[9] Correction of the fatigue test data to room temperature would increase the endurance limit obtained from fatigue tests about 14 percent to 2460 p.s.i. instead of 2160 pounds per square inch. After about 100,000 blows a crack was observed to form normal to the surface of the specimen at the point of contact with the striking ball. No indentation or marking of the surface of contact was observed to result from the striking of the balls until 100,000 blows. Tests with several different size balls indicated that the number of blows required to initiate this crack did not vary greatly with the size of ball.

Conclusions

From the results of fatigue tests and repeated impact tests of identical specimens conducted in a room maintained at constant temperature, 77° F., and constant relative humidity of 50 percent, it was concluded that:

1. Failure under repeated impact resulted from progressive fracture the same as occurred in fatigue tests.
2. An endurance limit existed at a stress of 2160 p.s.i. (the maximum stress in a cycle having a range from zero to a maximum).
3. The endurance limit was reached at about one million cycles.
4. The energy per blow corresponding to the endurance limit for a range of stress from zero to a maximum was less than one percent of the energy required to fracture a specimen in a single blow.
5. General yielding occurred in specimens which fractured in about 12 blows or less.
6. The straight-line portion of the $\sigma - N$ curve (log log plot) in which fracture occurred without general yielding can be represented by the equation

$$\sigma = \frac{17{,}000}{N^{0.143}}$$

This equation allows the calculation of the maximum stress due to impact which may be used in design of a part which will be subjected to a given number of impact stresses during its life.

7. The data shown in Fig. 5 seem to indicate that the endurance limit for repeated impact can be determined from fatigue tests.
8. A crack was also observed to occur normal to the surface of the specimen at the point of contact with the striking ball. This crack did not appear until about 100,000 blows, and did not result in fracture of the specimen.

Acknowledgments

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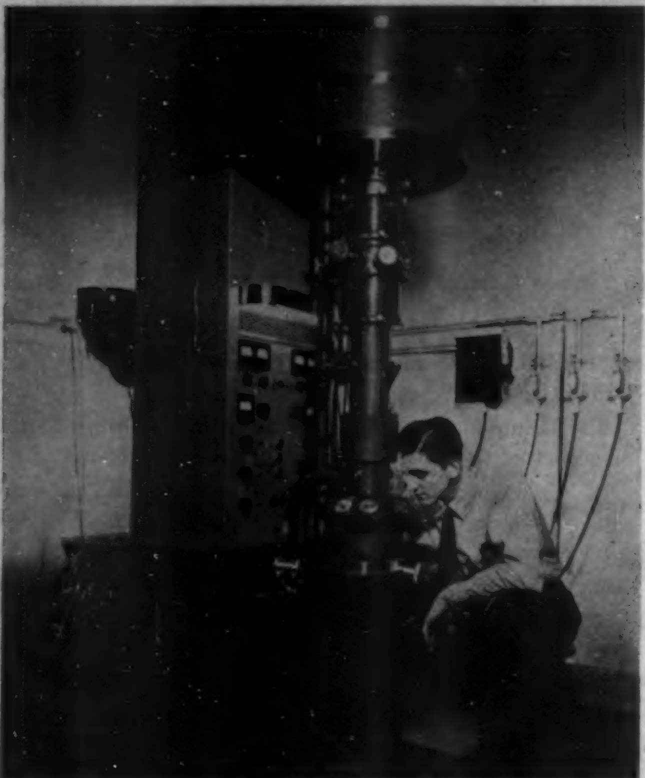
Polystyrene aids electron microscope*



ALL PHOTOS, COURTESY DOW CHEMICAL CO. 1

PLASTIC materials now are assisting man in many ways in his effort to solve nature's mysteries. One of the newest roles played by plastic materials—polystyrene in particular—has been that of a plastics "window." Through the use of this material as a supplement to the penetrating eye of the electron microscope, a vast new world containing many secrets locked in the interior of metals, now becomes visible. The exceptional properties of polystyrene moldings make this material suitable for recording faithfully the minute structures of metals visible in the electron microscope. With this plastic a precision molding may be made with such accuracy that details as small as 0.0000005 in. may be reproduced and what is more important—these dimensions are preserved even after chemical removal of the metal in acids or alkalies.

The electron microscope, as recently developed,[1] has made it possible to view transparencies of a much finer nature than were visible heretofore with the optical microscope. Actually, the extremely fine particles to be observed are deposited on films and the system viewed as a transparency. Surfaces of opaque objects could not be viewed until some treatment had been developed to reproduce those surfaces through the use of transparency. Several methods of producing such replicas have appeared in literature, chief among which are the natural oxide films of Mahl,[2] the direct Formvar films of Schaefer and Harker[3] and the silver-collodion process of Zworykin and Ramberg.[4] Research chemists and physicists working in the laboratories of the Dow Chemical Co. have developed a new replica technique which has been applied successfully to a number of different surfaces. It is a 2-step process using polystyrene as the first replica and an evaporated silica film as the second replica. The second replica is the one viewed in the electron microscope, but it is not possible without the development of the first thermoplastic replica.

The method of formation of these replicas is not complicated.[5,6] It consists of making a plastic impression against the material to be viewed. After the surface of the material to be studied (such as a metal) is polished and etched through satisfactory techniques, polystyrene is molded against it. Commercial, low-viscosity, dust-free molding powder in the form of granules is suitable, while an ordinary mounting press will serve for making the molding. The specimen, mounted

* Compiled from manuscripts by Dr. L. A. Matheson and R. D. Heidenreich, Dow Chemical Co.

[1] V. K. Zworykin, J. Hillier and R. L. Snyder, A.S.T.M. Bulletin No. 117, 15–23 (1942).
[2] H. Mahl, Zeits. f. tech. Physik *22*, 93 (1941).
[3] V. J. Schaefer and D. Harker, J. Applied Physics *13*, 427 (1942).
[4] V. K. Zworykin and E. G. Ramberg, J. Applied Physics *12*, 692 (1941).
[5] R. D. Heidenreich and V. G. Peck, "Electron Microscope Study of Surface Structure," The Physical Review *62* Nos. 5 and 6, 292–293 (Sept. 1 and 15, 1942).
[6] R. D. Heidenreich and V. G. Peck, "Fine Structure of Metallic Surfaces with the Electron Microscope," J. Applied Physics *14*, No. 1, 23–29 (Jan., 1943).

1—Electron miscroscope as used by chemists and physicists in the research laboratory. 2—Etched, pure magnesium viewed through polystyrene-silica technique. 3—A fractured magnesium surface view through this same technique

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or unmounted, is placed in the press with sufficient polystyrene granules on the surface to give a final molding of a thickness of about $^1/_2$ inch. The mold then is heated to 130° C. before any pressure is applied since premature application of pressure will press the hard granules against the surface and possibly result in specimen deformation. This is particularly true of soft metals. A pressure of 2000 to 5000 lb. can be applied and the temperature raised to 160° C. The mold then is allowed to cool while constant pressure is maintained until the temperature has dropped to well below 80° C. This precaution prevents formation of bubbles in the molding. If decreased molding pressures are desirable, they can be obtained through use of high molding temperatures to 200° C.

Metal can be removed from the polystyrene either by mechanically jarring it loose or, preferably, by dissolving the metal in an acid. Polystyrene is extremely resistant to most acids and is unaffected by the common acids that normally would be used for dissolving the metal specimen. Any of the mineral acids in a moderate concentration (1:3), except sulfuric acid, can be used safely without damage to the polystyrene. Acetic acid and caustic also may be used. When the metal is dissolved the polystyrene surface is washed with dilute acid followed by a swift stream of double distilled water. Then it is dried in clean air. Next it should be examined in a light microscope for any dirt or salt that might remain on the polystyrene surface.

The second step of the replica preparation is known as the silica evaporation. Actually, the silica is condensed on the styrene replica surface (in vacuum) from a conical tungsten filament. Pure quartz in the form of small splinters is placed in this conical film, and the styrene molding mounted vertically above it at a distance of 6 to 8 cm. Rapid evaporation of the quartz (30 sec.) then is brought about without causing the temperature of the styrene surface to rise above 50° C. The amount of quartz to be evaporated will depend on the roughness of the surface. The silica as it condenses on the polystyrene surface appears to be very fluid. Accordingly it fills all of the depressions and then sets thermally to a solid material. It tends to fill all depressions of size greater than 1 μ across. The sample, after being cut into squares, should be placed in ethylene bromide with (*Please turn to page 160*)

4—Highly polished steel surface viewed through polystyrene-silica technique. 5—View of slip bands in a calcite crystal through this same technique. 6—Etched stainless steel seen through polystyrene-silica technique. 7—Etched copper viewed through this same technique

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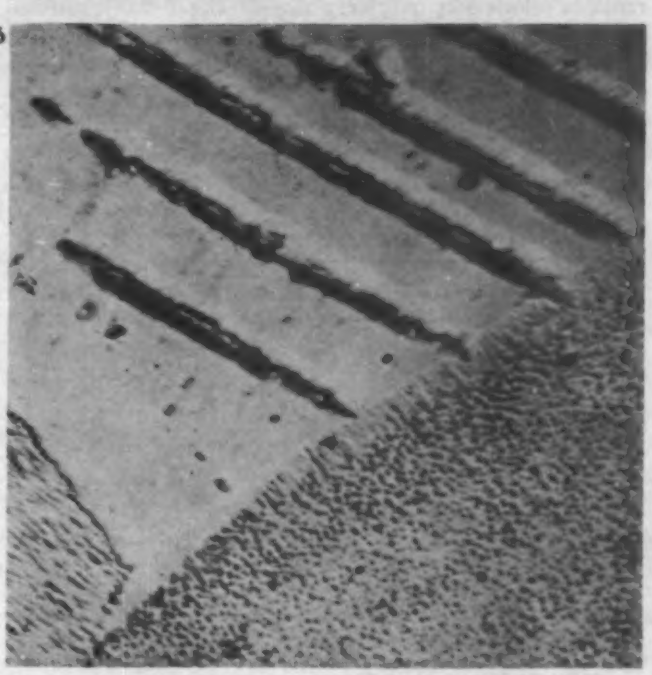

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Fluorescent dyes in coatings and plastics

by HENRY E. MILLSON and CLIFTON C. CANDEE*

WITH the increasing use of fluorescent dyes in Government and civilian fields, a new interest has been aroused in the application of these materials. The incorporation of fluorescent dyes into plastics, lacquers and other top coatings has created a demand for data on the solvent solubility of these colors. Fortunately, many of the most fluorescent dyes that are known are soluble in coating solvents. Qualitative solubilities for various fluorescent dyes are presented in Table I.

The degree of solubility of the dyes has been indicated as insoluble, sparingly soluble and soluble. If a solvent remains colorless or only very slightly tinted when warmed in intimate contact with a dyestuff, the dye has been rated as "insoluble." The dye has been listed as "sparingly soluble" in those cases where the solvent was definitely stained, but the bulk of the dye remained undissolved. Those dyes which give a heavily colored solution such as would be used as a base solution for most fluorescent dye applications have been rated as "soluble." It must be emphasized, however, that a rating of "soluble" in a specific solvent or plasticizer has no bearing on the fluorescence of the dye in the material. Several fluorescent dyes dissolve readily but show very little, if any, fluorescence in solution. All results are based on solutions of not over 3 percent. The solvents used were commercial types. The alcohol was 3A grade; the solubility of some of the dyes would probably be lower in absolute alcohol.

It must be borne in mind that solvent inert materials sometimes are incorporated in dyestuffs for standardization purposes or to aid in normal dyeing procedures. The insolubility of the inert materials is an advantage since it permits their ready removal by filtration.

Formulating with fluorescent dyes

Formulating with fluorescent dyes differs markedly from formulating with pigments in two major respects: first, in the amount of color used; and second, in shading for color values.

* Calco Chemical Div., American Cyanamid Co.

TABLE I.—SOLUBILITY OF FLUORESCENT DYES IN VARIOUS TECHNICAL GRADE SOLVENTS AND PLASTICIZERS

Fluorescent dyes	*Water*	*Alcohol 3A*	*Butyl acetate*	*Acetone*	*Tolulol*	*Solvent naphtha*	*50% Butanol 50% Xylol*	*33 1/3% Amyl alcohol 33 1/3% Ethyl acetate 33 1/3% Xylol*	*Turpentine*	*Cellosolve*	*Carbitol*	*70% Carbitol 30% Cellosolve*
Calcocid uranine B-4315	S	S	I	I	I	I	I	I	I	S	S	S
Calcocid rhodamine B conc.	S	P	I	I	I	I	P	I	I	S	P	S
Calcocid rhodamine 3B conc.	S	P	I	S	I	I	P	S	I	S	P	S
Calcocid fluorescent blue G	S	I	I	I	I	I	I	I	I	I	I	I
Calcozine flavine TG Ex. conc.	S	S	I	I	I	I	S	I	I	S	S	S
Calcozine yellow OX	S	S	I	I	I	I	S	I	I	S	S	S
Calcozine red 6G Ex.	S	S	I	I	I	I	S	S	I	S	S	S
Calcozine red BX	S	S	I	I	I	I	S	S	I	S	S	S
Calco eosine J	S	S	I	P	I	I	I	I	I	S	S	S
Calco bromo #54	P	S	S	S	I	I	S	S	I	S	S	S
Calcomine brilliant flavine S	S	P	I	I	I	I	I	I	I	I	S	S
Calcomine diazo scarlet PRD	S	P	I	I	I	I	I	I	I	I	S	S
Calcomine fluorescent orange YF	S	I	I	I	I	I	I	I	I	P	S	S
Calcomine fluorescent pink B	S	S	I	I	I	I	I	I	I	S	S	S
Calcomine fluorescent blue BB	S	I	I	I	I	I	I	I	I	S	P	P
Calcomine fluorescent violet G	S	P	I	I	I	I	I	I	I	I	P	S
Calcomine fluorescent green C	S	P	I	I	I	I	I	I	I	S	S	S
Calco fluorescent yellow AB	I	S	S	I	S	I	S	S	S	S	S	S
Calco fluorescent yellow HEB	I	S	S	S	S	I	S	S	S	S	S	S
Calco auramine base conc.	I	S	P	S	S	I	S	S	P	S	S	S
Rhodamine B. stearate conc.	I	S	P	S	S	P	S	S	S	S	S	S
Non-fluorescent dyes for toning												
Calcocid milling fast green CR	S	S	I	I	I	I	I	I	I	S	S	S
Calcocid aliz. blue SAPG	S	I	I	I	I	I	I	I	I	I	P	P
Calcozine blue B Ex. conc.	S	S	I	P	I	I	S	P	I	S	S	S
Calcozine brilliant green G	S	S	I	P	I	I	S	P	I	S	S	S
Calcozine green V	S	S	I	P	I	I	S	I	I	S	S	S

Abbreviations: S = Soluble. P = Sparingly soluble. I = Insoluble.

The amount of dyestuff used must be carefully worked out for each specific application to obtain a maximum of fluorescent brilliance. A range from a minimum quantity to a maximum quantity generally can be worked out through which a variation in intensity and shade can be controlled, and at the same time a peak of fluorescent brilliance maintained. In producing pastel shades, the dye content may tend to run below the minimum. This may result in almost complete loss of fluorescence under ultraviolet light because the fluorescent molecules are so far apart that they produce only a faint bluish-white glow or are completely undetectable. This may seem remote, but minute quantities of soluble dyes produce relatively large shade changes and even full strength formulations may contain only 0.4–0.5 percent of dye in the final dry film. In producing the heaviest shades, care must also be taken not to exceed the established maximum dye content for a particular application. The effect of an excess of dye is a marked dulling effect on fluorescent brilliance.

No hard and fast rules can be given establishing the quantity of dye to be used. However, Table II shows a series of 5 brilliantly fluorescent enamels (formulated for test purposes only) which may be used as a guide or starting point for dye usages when developing fluorescent top-coatings. Table II also illustrates how combinations of various solvents may be used advantageously to increase dye concentrations when this is necessary.

Shade matching with fluorescent colors not only presents those problems ordinarily encountered in color work, but also is complicated by the fact that the fluorescent color may be entirely different from that of the visible light color. Thus, a dye or compound that is colorless or faintly tinted in visible light may be blue (Calcomine fluorescent violet G) or green (anthracene) under ultraviolet light. However, by careful manipulation these complications can be used to advantage to produce an infinite number of different effects in shade and tone. Table II shows how Calcomine fluorescent violet G has been given a bright blue daylight color with Calco ultramarine blue No. 1401. The addition of the non-fluorescent ultramarine blue appeared to actually increase the fluorescent intensity of the Calcomine fluorescent violet G. However, when certain non-fluorescent dyes were substituted for the ultramarine blue in the same formulation, the intensity of fluorescence of the coating was so reduced that it was of no interest.

The addition of a small amount of non-fluorescent dyestuff to a fluorescent coating may reduce its brilliance far out of proportion to the amount added. This effect is probably produced by the differences in absorption and reflectance properties of the various dyes in both the ultraviolet and visible light wave lengths. It is probable that this "interference" between dyes could be predicted by spectrophotometric tests, but these are not generally available and the

TABLE I—*(continued)*

Ethylene glycol	*Ethylene dichloride*	*Glycerine*	*Clear Russian Mineral Oil*	*Castor oil (bodied)*	*Butyl stearate*	*Alkyl ricinoleate*	*Dibutyl phthalate*	*Tri cresyl phosphate*	*Methyl phthalyl Ethyl glycolate*	*Hydrogenated methyl abietate*	**Rezyl 99-1*	*Chlorinated Diphenyl*	*Fluorescent dyes*
S	I	S	I	I	I	I	I	I	I	S	I	I	Calcocid uranine B-4315
S	I	S	I	S	I	S	I	P	S	I	S	I	Calcocid rhodamine B conc.
S	I	S	I	I	I	S	S	P	S	I	S	I	Calcocid rhodamine 3B conc.
S	I	S	I	I	I	I	I	I	I	I	I	I	Calcocid fluorescent blue G
S	I	S	I	I	I	S	I	I	P	I	S	I	Calcozine flavine TG Ex. conc.
S	I	S	I	I	I	S	P	I	S	I	S	I	Calcozine yellow OX
S	S	S	I	P	I	S	P	S	I	S	S	I	Calcozine red 6G Ex.
S	S	S	I	S	I	S	I	S	S	I	S	I	Calcozine red BX
S	I	S	I	I	I	P	I	I	I	S	S	I	Calco eosine J
S	P	S	I	I	I	P	P	S	P	P	S	S	Calco bromo #54
S	I	S	I	I	I	I	I	I	P	I	P	P	Calcomine brilliant flavine S
S	I	S	I	I	I	I	I	I	I	I	I	I	Calcomine diazo scarlet PRD
S	I	S	I	I	I	I	I	I	P	I	P	P	Calcomine fluorescent orange YF
S	I	S	I	I	I	I	I	I	I	I	I	I	Calcomine fluorescent pink B
S	I	S	I	I	I	I	I	I	I	I	I	I	Calcomine fluorescent blue BB
S	I	S	I	I	I	P	I	P	I	P	P	P	Calcomine fluorescent violet G
S	I	S	I	I	I	I	I	I	P	I	P	I	Calcomine fluorescent green C
S	S	S	I	S	S	S	S	S	S	S	S	S	Calco fluorescent yellow AB
S	P	S	I	S	S	S	S	S	S	P	S	S	Calco fluorescent yellow HEB
S	S	S	I	S	S	S	S	S	S	S	S	S	Calco auramine base conc.
S	S	S	S	S	S	S	S	S	S	S	S	S	Rhodamine B. stearate conc.
													Non-fluorescent dyes for toning
S	I	S	I	I	I	I	I	I	I	I	S	I	Calcocid milling fast green CR
S	I	S	I	I	I	I	I	P	I	I	P	I	Calcocid aliz. blue SAPG
S	S	S	I	S	I	P	P	S	S	P	S	I	Calcozine blue B Ex. conc.
S	S	S	I	I	I	P	P	S	S	P	S	P	Calcozine brilliant green G
S	S	S	I	S	I	P	P	S	S	I	S	P	Calcozine green V

* Non-oxidizing alkyd resin in 50 percent mineral spirits.

Table II.—Test Formulations for Fluorescent Enamels

Color	Dye or resin	Dye	Resin	Butanol	Xylene	Carbitol	Butyl cellosolve	Total formula	Amount of dye in dry film	Notes
		g.	g.	ml.	ml.	ml.	ml.	ml.	%	
Yellow	Calco fluorescent yellow AB	0.5	...	...	...	7.5	17.5	25.0	0.8	Dissolve dye hot
	Beetle 227-8	..	61.8	38.6	38.6	..	..	139.0	...	
Green	Calco fluorescent yellow AB	0.5	...	...	...	7.5	17.5	25.0	0.4	
	Calcodid milling fast green C.R.	0.5	...	25.0	...	..	..	25.0	0.4	Dissolve hot and filter
	Beetle 227-8	..	123.5	77.2	77.2	..	..	278.0	...	
Red	Calco rhodamine B stearate	6.25	...	20.0	25.0	..	..	50.0	4.27	
	Beetle 227-8	..	140.0	88.0	88.0	..	..	315.0	...	
Orange	Calcozine red 6G Ex.	0.5	...	12.5	12.5	..	..	25.0	0.715	
	Beetle 227-8	..	69.4	43.3	43.3	..	..	156.0	...	
Blue	Calcomine fluorescent violet G	1.6	...	...	...	12.0	28.0	40.0	0.9	Dissolve hot and filter
	Ultramarine blue 1401	8.0	...	...	...	..	..	...	...	Ball mill 24 hr.
	Beetle 227-8	..	17.8	12.3	14.3	..	..	50.6	4.5	
	Beetle 227-8	..	160.2	100.0	100.0	...	..	360.0	...	

same result can be obtained visually by actual blend tests.

In Table II, examples of the use of both non-fluorescent dyes and pigments are illustrated. In the case of the green, a non-fluorescent dyestuff has been added to a fluorescent yellow to produce both a green daylight effect and a green fluorescence under ultraviolet light. In this case, a slight loss of fluorescent intensity is noted. In order to give a blue color in both visible and ultraviolet light, a non-fluorescent blue pigment has been added to a coating which is colorless in visible light and fluoresces blue in ultraviolet light. In this instance, in fact, no loss of fluorescence is noted and increase in intensity has been obtained.

The toning or shading of fluorescent colors is most readily accomplished by using other fluorescent colors whenever the proper shades are available. However, it must be kept in mind that the regular color matching rules no longer apply when dealing with fluorescent colors viewed in ultraviolet light. For example, a mixture of Calco fluorescent yellow AB (greenish yellow fluorescence) and Calcomine fluorescent violet G (blue fluorescence) would be expected to fluoresce green if judged by normal color blending rules, but under ultraviolet light the mixture fluoresces yellow. Here, again, these complicating factors permit unusual effects to be obtained with a little ingenuity in manipulation.

Effect of vehicles on fluorescent dyes

In formulating with fluorescent dyes, care must be exercised in selecting the vehicle. For example, Calco rhodamine B stearate formulated with Melmac 245-8, changes on baking to a deep maroon with no fluorescence. However, when formulated with Beetle 227-8 and baked, no change occurs.

Table III.—Effect of Various Vehicles on the Permanence of Calco Fluorescent Yellow AB

Vehicle	Exposure record in standard fade-ometer
	hr.
Cellulose nitrate	Less than 1
Damar varnish	Less than 1
Ethyl cellulose, 60 percent Beetle 227-8, 40 percent	8
Melmac 245-8	16
Melmac 560-8	32
Beetle 227-8	128

Still more important in the selection of the vehicle is its effect on the permanence of fluorescence to visible and ultraviolet light exposures. Table III shows in tabular form the wide variations in light fastness of one fluorescent dyestuff in various vehicles. Not all dyes are equally affected, but differences will be observed. When formulated in cellulose nitrate at less than one hour of exposure, the fluorescence had almost completely disappeared. By contrast, when formulated in the Beetle 227-8, even at 128 hr., about 50 percent of the original intensity was retained.

Of course, it must be remembered that organic dyestuffs do not, in general, exhibit the permanence of pigment-type fluorescent compounds. Therefore, fluorescent dyes should not be used in coatings which are to be exposed to ultraviolet, daylight or incandescent light for extended periods of time. The usefulness of fluorescent dyes is the greatest in those applications where *extreme brilliance* is required without maximum fastness.

Effect of base to which coatings are applied

Since many fluorescent lacquers are transparent, it is obvious that the texture of the base, its color and other properties will have a marked influence on the intensity of a fluorescent coating. The greatest loss of fluorescence is caused by the color of the base. Maximum brilliance is obtained over white. Theoretically, all other factors being equal, the least fluorescence is obtained over black.

A series of experiments have been run to show exactly how the brilliance of fluorescence of transparent coatings is affected when used over various non-fluorescent colors. Three sets of 10 samples each were prepared. The first set consisted of 10 coated paper backgrounds of different colors with little or no fluorescence. The second set consisted of the same 10 background colors sprayed with a transparent fluorescent coating of Calco rhodamine B stearate formulated as shown in Table II. The third set was similarly treated except coated (*Please turn to page 160*)

TECHNICAL BRIEFS

Abstracts of articles on plastics in the world's scientific and engineering literature relating to properties and testing methods, or indicating significant trends and developments

Engineering

USE OF SARAN FOR WATER PIPES IN BUILDINGS AND FOR SERVICE LINES. F. M. Dawson and A. A. Kalinske. J. Am. Water Works Assoc. *35*, 1058–64 (Aug. 1943). The bursting strengths of $^5/_8$- and $^3/_4$-in. outside diameter pipe, 0.062-in. wall-thickness, made from vinylidene chloride plastic were measured when water of the indicated temperature was circulated in the pipe for one hour and then the water pressure was raised until failure occurred. The results are as follows: for $^3/_4$-in.—350 p.s.i. at 170° F., 300 p.s.i. at 185° F., 270 p.s.i. at 200° F. and 240 p.s.i. at 210° F.; for $^5/_8$-in.—600 p.s.i. at 170° F., 550 p.s.i. at 185° F., 500 p.s.i. at 200° F. and 500 p.s.i. at 210° F. The results of water-hammer tests indicated that the weak point was the flare-type fittings; when changes from the usual method of preparing these joints were made the results were satisfactory. The maximum water-hammer pressure developed is only $^1/_4$ to $^1/_3$ that in iron pipe of the same internal diameter for the same rate of flow. Considerable cushioning is afforded, so that other equipment connected to the system will not have to withstand excessive shock pressures. Water-hammer noises are also lessened. The results of pressure loss tests indicate that the smooth-pipe law is followed; the plastic pipe is comparable to brass, copper, lead and glass in this respect. Appreciable pressure loss arises from the present fittings because their internal diameter is less than that of the tubing. Laboratory tests with white rats indicate that they will begin to chew on the tubing only when they are starved or deprived of water. Polyvinylidene chloride tubing is recommended for cold water lines and on an experimental basis for hot water lines.

PROBLEMS IN WOOD AIRCRAFT. I. C. Peterson. S.A.E. Journal *51*, 369–80 (Oct. 1943). Attempts to take advantage of the high tensile strength of wood will lead to failures in shear because loads theoretically in tension practically always have shear components that are great enough to overcome the low shear strength of wood. Moisture content also has a great effect on the strength of wood; and the moisture equilibrium of a piece of wood will vary with the relative humidity and temperature to which it is exposed. The fabrication of wood structures revolves around the production of strong glue joints. The most important conditions involved in the production of strong glue joints are a sufficient spread of glue on smooth wood surfaces and a correct balance between the temperature, pressure and the glue consistency at the time the pressure is applied. Fabrication is intimately related to gluing operations, and until the aircraft manufacturers solve their gluing problems they always will have fabrication problems. The use of above-normal temperatures has been recommended for reducing the pressing periods required for cold-press glues. The effect of these high temperatures on the final glue-joint strength is not known, and manufacturers should be cautious in the use of setting temperatures in excess of 150° F.

STANDARD TOLERANCES. M. Freund. British Plastics *15*, 204–8, 210, 212 (Sept. 1943). In a previous article the standard tolerances for the general dimensions of moldings were discussed. Location of holes and inserts, misalignment, eccentricity, bow and warping, and wall thicknesses are considered in quantitative terms in this contribution. See MODERN PLASTICS, 96 (July 1943).

Chemistry

THIRTY YEARS' CONTRIBUTIONS TO THE SCIENCE OF SYNTHETIC RUBBER. W. L. Semon. Chem. Eng. News *21*, 1613–19 (Oct. 10, 1943). The history of synthetic rubber science is traced from the work of Kyriakides and Earle in 1910 to the present day.

RESINOUS PRODUCTS OF CONDENSATION OF PHENOL WITH ACETALDEHYDE. A. A. Vansheldt, A. T. Itenberg and V. S. Shifrina. J. Gen. Chem. (U.S.S.R.) *12*, 500–8 (1942). Paraldehyde was added dropwise over a period of 30 min. to phenol containing 1 percent hydrochloric acid, and the mixture allowed to stand overnight. The mixture was then refluxed at 140° C. until 2 consecutive samples showed no change in free phenol content. The mixture was steam distilled, and the resin powdered and dried in vacuo. When the molal ratios of phenol to aldehyde ranged from 3.0 to 0.5, the molecular weights of the resins ranged from 270 to 1150, respectively. Condensation of acetaldehyde with phenol in acid medium with a large excess of phenol present yields 4, 4′-dihydroxyphenylmethylmethane. When the molal ratio of phenol to aldehyde is 3 or less, resins are formed. As the molal ratio is lowered the molecular weight and softening point of the resin increases, but the yield of resin decreases. The resin contains the meso-ethylidene-polyphenol structure. More phenol is used than is indicated on a theoretical basis; the magnitude of the excess decreases with a decrease in the molal ratio of phenol to aldehyde which is in the starting mixture.

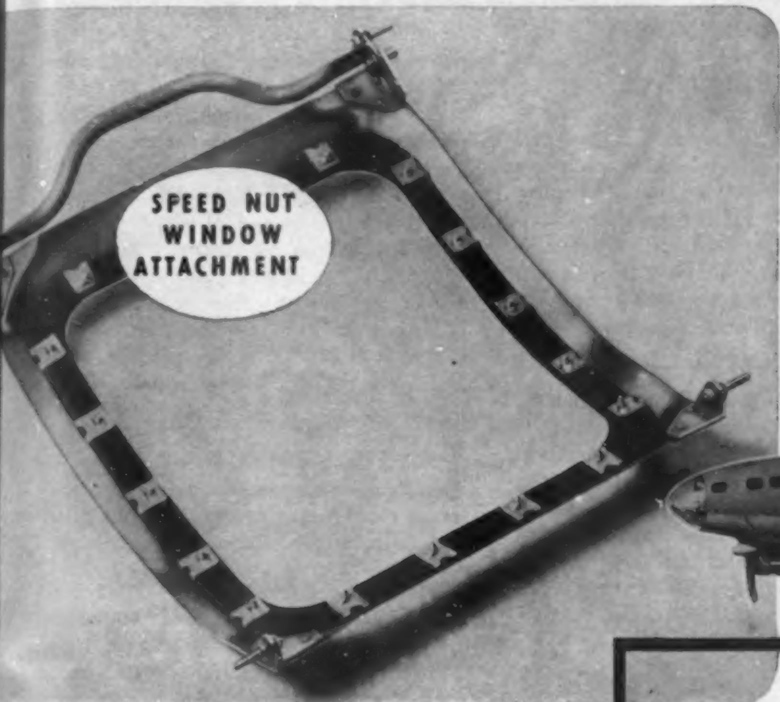
NYLON YARN AND ITS POSSIBILITIES. G. Loasby. J. Text. Inst. Manchester *34*, P45–P63 (Mar. 1943). The mechanical, thermal and electrical properties, moisture absorption, refractive index, degradation, viscosity, insect and bacterial resistance, recovery from strain, elasticity and dyeing properties of nylon are discussed. The potential applications of nylon yarns are enormous. The fiber is expected to find application in fabrics where strength combined with lightness and low moisture content or quick drying are desired. With wool it forms mixtures which can be easily dyed. Nylon staple works well on both the woolen and worsted systems. Nylon can be made into fibers on the spun-silk principle with excellent results.

MOLECULAR WEIGHTS OF HIGH POLYMERS. M. L. Huggins. Ind. Eng. Chem. *35*, 980–5 (Sept. 1943). The equations generally used for the calculation of molecular weights from osmotic pressure or cryoscopic data are valid only at infinite dilution; their use with data obtained at finite concentrations, without extrapolation to infinite dilution, leads to very large errors if the solute molecules are large. The use of Staudinger's rule to obtain molecular weights of high polymers is, theoretically and experimentally, unjustifiable for most polymer-solvent systems. The more general relationship, $\left(\frac{\eta_{sp}}{c}\right)_{c=0} = KM^{\nu}$ where η_{sp} = specific viscosity, c = concentration, M = molecular weight, and K and ν are constants to be determined empirically, is certainly more satisfactory. But whether or not this form of equation is really adequate remains to be proved. At present empirical intrinsic viscosity-molecular weight curves must be determined using polymer samples which are molecularly homogeneous, before true molecular weights can be deduced from viscosity data. Osmotic pressure and cryoscopic data yield ordinary number-average molecular weights. Viscosity data, properly interpreted, yield another sort of average in which the heavier molecules are relatively more important. These 2 types of molecular weights give a better characterization of a polymer than either alone.

Testing

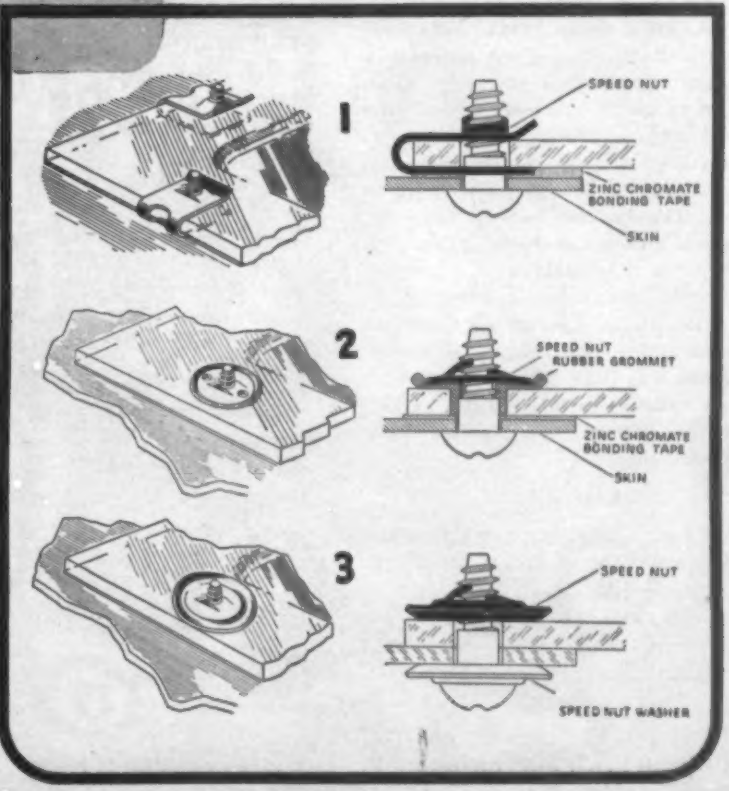
USE OF DRY ICE FOR TESTING. Aero Digest *43*, 222 (Sept. 1943). A cold test room cooled by dry ice-methanol mixtures is described. This system cools the room to —98° F., has low first cost and is simple to operate and maintain. It is recommended only for infrequent use. For test rooms which must be operated constantly the use of refrigeration compressors is more desirable because of low operating cost. Combinations of the 2 systems may be utilized satisfactorily to take care of infrequent heavy loads.

Speed Nuts IMPROVE Plastic Window *Assembly*



SPEED NUTS answer the problem of attaching plastic windows without danger of fracturing. They provide a spring-tension grip that frees the assembly from dead-tight fastening pressure. They also hold the plastic firmly in locked position under vibration and permit expansion and contraction of the plastic without damage. Washers are not needed as the wide bearing surface of the SPEED NUT spreads the load over a greater area and away from the screw hole. These SPEED NUTS are also applied faster—saving many manhour's time and reduce the net weight of the assembly. **In the first case illustrated, a "U" type Speed Nut snaps over plastic edges in self-retaining position. A round type Speed Nut is used in the second installation with rubber grommets in larger screw holes for additional cushion and seal. In the third method, where 2 pieces of plastic overlap, a cup-shaped Speed Nut is used with a mated Speed Nut washer—both formed to extend the load farther from the screw hole.**

In writing for samples kindly give engineering details.



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PLASTICS DIGEST

This digest includes each month the more important articles of interest to those who make or use plastics. Mail request for periodicals mentioned directly to publishers

General

FILLERS IN THE PLASTICS INDUSTRY. W. C. Gangloff. Chemical Industries *53*, 512–14 (Oct. 1943). The various fillers used in plastics are discussed. The types considered include woodflour, cotton fibers, rag, ramie fibers, wood chips, excelsior, sawdust, vegetable proteins, animal hair, redwood, sisal, asbestos, mica, silicates (glass, clay, diatomaceous earth, etc.), talc, barium sulfate, titanium oxide, zinc oxide, bagasse, walnut shell and graphite.

MORE SYNTHETIC RESINS FROM ROSIN. J. R. Callaham. Chem. and Met. Eng. *50*, 109–11 (Oct. 1943). The various synthetic resins produced from rosin are described. A new modified pentaerythritol ester of rosin is among the group. The manufacture of this resin is described.

RADIANT HEATING INVADES INDUSTRY. C. P. Mann. Chemical Industries *53*, 332–5 (Sept. 1943). Radiant heating is discussed, and the progress in industrial utilization is reviewed. Two types of radiant heating are in use: the infrared lamp and the radiant gas burner. Radiant energy is inherently directional and is readily and rapidly responsive to control. The shape of the piece, the color, the type of surface and the weight must be considered in utilizing this form of heating. The shorter the distance between the source and the work, the more efficient the application. An increase in the distance from 6 to 10 in. will extend the curing time as much as 500 percent. Various applications of both types of radiant heating are described.

Materials

SHELLAC. ITS USES IN MODERN INDUSTRY AND IN WAR-TIME. A. J. Gibson. Chemistry and Industry *62*, 346–48 (Sept. 11, 1943). This is a short review of the present knowledge concerning the composition of shellac, its properties and applications.

THE COMPARS—NEW FAMILY OF RUBBER-LIKE MATERIALS. E. S. Peierls. Rubber Age *54*, 41–2 (Oct. 1943). The general characteristics and applications of compounded polyvinyl alcohol resins are described. The materials are transparent, flexible, rubber-like and solvent resistant. They are being used for fuel and oil hose, protective clothing, laboratory tubing, washers, gaskets, transmission rings and diaphragms. Materials are also available in solution form for coating metal, wood, fabric and paper.

PLIOFILM. Modern Packaging *17*, 103–7 (Oct. 1943). The prewar development of rubber hydrochloride film as a packaging material for foods and its future possibilities are discussed. Data are tabulated regarding the strength properties of Pliofilm and its permeability to moisture and gases.

CARBON BLACK IN BUTYL RUBBER. L. B. Turner, J. P. Haworth, W. C. Smith and R. L. Zapp. Ind. Eng. Chem. *35*, 958–63 (Sept. 1943). If tensile strength alone is considered, carbon pigments which reinforce natural rubber do not reinforce Butyl. When the enhancement of other physical properties associated with reinforcement such as modulus and tear resistance are considered, it can be said that the types which reinforce natural rubber also reinforce Butyl.

Applications

PRESENT DAY USE OF NATURAL OILS AND RESINS IN PRINTING INKS. F. E. Petke and C. H. Allen. Chemical Industries *53*, 502–4 (Oct. 1943). The natural oils and resins now used in the manufacture of printing inks are discussed. Better materials are needed; the properties of improved oils and resins needed for this application are mentioned.

MELAMINE RESINS FOR WET STRENGTH PAPER. Modern Packaging *17*, 88–9 (Sept. 1943). Melamine treatment of paper pulp improves the wet tensile strength and increases the folding resistance of the dry sheet. Cellulose fibers treated with not more than 3 percent of melamine resin acidified with hydrochloric acid retained between 70 and 90 percent of the added resin. Other types of treatments such as glue-formaldehyde, urea resin and parchmentization are compared with melamine treatment.

Coatings

HEAT RESISTING AND STOVING FINISHES. R. L. Frost. Chemistry and Industry *62*, 306–10 (Aug. 14, 1943). The properties and uses of heat-resisting and baked coatings are discussed. The various types considered are: 1) alkyd resin, 2) medium- and long-oil alkyd resins modified with semi-dry oils, 3) medium- and long-oil alkyd resins modified with drying oils, 4) medium- and long-oil alkyd resins modified with drying oils and other resins, 5) short-oil alkyd resins modified with drying oils and other resins, 6) urea-formaldehyde resins, 7) combinations of urea-formaldehyde and alkyd resins, 8) melamine-formaldehyde resins, 9) phenol-formaldehyde resins, 10) oil-soluble phenolic resins, 11) oil-soluble modified phenolic resins, 12) bituminous materials, 13) linseed oil, 14) linseed oil varnishes, and 15) sodium silicate. The effects of solvents, pigments and driers in formulating these finishes and the preparation of surface, application of finish and various baking methods are discussed.

AUTOMOBILE FINISHES. Automobile Eng. *33*, 360 (Sept. 1943). The development of body lacquers to give increased gloss and abrasion resistance is described. The following general formula is recommended: cellulose nitrate, $^1/_2$ sec. (30 percent Pentasol) 23.1 percent; blown castor oil 6.2 percent; tricresyl phosphate 3.1 percent; dammar resin 4.0 percent; pigment (prussian blue and zinc oxide) 7.1 percent; Pentacetate 22.0 percent; Pentasol 6.1 percent; toluene 9.0 percent; Troluoil 14.0 percent and xylene 5.4 percent. The thinner consists of 35 percent Pentacetate, 17 percent Pentasol, 24 percent toluene and 24 percent Troluoil. The lacquer is thinned 3 to 1 for spraying. The drying time is 12 to 15 min. at 70° F. with a relative humidity of 55 percent, and the tensile strength of the film after 48 hr. drying on mercury coated tin is 215 kg./cm.^{2} with an elongation of 6 percent. Three double-sprayed coats of film have a thickness of 0.002 to 0.003 in., and with 2 coats on tin dried for 48 hr. it required 48 gm. of carborundum to wear a hole through film. After drying for 10 days 80 gm. of carborundum were necessary.

THE PERMANENCE OF PAINTS. E. Karsten. Z. Metall und Schmuckwaren-Fabrik. sowie Verchrom. *23*, 197–200 (1942). Sheets of iron, bonded iron, galvanized iron, steel, polished nickel, polished zinc, aluminum, MBV treated aluminum, Duralumin, Duralplate, dichromate pickled Electron metal, aluminum pretreated 550/200, aluminum pretreated 300/800 and Hydronalium 5 were cleaned with solvents and covered with 2 coats of lacquer to a total thickness of 60 microns. The lacquers used were cellulose nitrate, air-dried alkyd resin, oven-dried alkyd resin, Albert oil-linseed oil-wood oil, oil-free phenolic resin, chlorinated rubber and polyvinyl chloride-polyacrylate. All the lacquers were pigmented with titanium dioxide. The coated panels were aged by immersing in 3 percent sodium chloride, then alternately sprayed with water for 24 hr. and heated at 80° for 24 hours. The adhesion of the coatings was evaluated after 3, 10 and 18 days by scratching with a sharp knife. Tests were made when the coatings were both wet and dry. Grating and bending tests also were used. The order of decreasing adhesion according to the average evaluation was as follows: (1) For the lacquers; oil-free phenolic resin, oven-dried alkyd resin, cellulose nitrate, chlorinated rubber and the oil lacquer. (2) For the metal bases; bonded iron, iron, aluminum 300/800, aluminum 550/200, Duralplate, steel, Electron metal, Hydronalium, galvanized iron, aluminum MBV, polished zinc, Duralumin and polished nickel.

Ewing Galloway

U. S. Plastics Patents

Copies of these patents are available from the U. S. Patent Office, Washington, D. C., at 10 cents each

PLASTIC SHEETS. C. B. Eglof (to Rohm and Haas Co.). U. S. 2,328,525, August 31. Sheets of polymeric materials are formed by preparing a cell of 2 plates of rigid material separated by fluid tight spacers filling the space with polymerizable material, initiating polymerization and continuing until a thick viscous material is formed, removing spacers, and continuing polymerization until a rigid sheet is formed.

RESINOUS MIXTURES. I. C. Matthews and W. F. Rich (to Eastman Kodak Co.). U. S. 2,328,566–7, September 7. A mixture of a coumarone-indene cyclo olefine resin with a halogenated rubber, and the reaction product of an alpha beta dicarboxylic acid anhydride with terpinene and the mixture of a halogenated rubber with the reaction product of a polybasic acid anhydride with terpinene.

CONDENSATION PRODUCTS. G. Widmer and W. Fisch (to Ciba Products Corp.). U. S. 2,328,592–3, September 7. A molding composition comprising a cellulose filler and the condensation product of an aldehyde, a phenol and a substituted triazine, and the method for preparing the condensation product.

POLYVINYL BUTYRAL SHEET MATERIAL. E. F. Izard (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,328,646, September 7. Polyvinyl butyral sheet material is plasticized with a monocarboxylic acid di-ester of octadecanediol 1:12.

COPOLYMER. W. Scott and R. B. Seymour (to Wingfoot Corp.). U. S. 2,328,748, September 7. A copolymer of vinyl chloride, vinylidene chloride and vinyl acetate.

STRETCHING FILMS. R. C. Martin (to Wingfoot Corp.). U. S. 2,328,827, September 7. An apparatus for continuous lateral stretching of thermostretchable, elastoplastic film.

STRETCHING FILMS. H. J. Osterhof (to Wingfoot Corp.). U. S. 2,328,843, September 7. A method for stretching a film and preventing its shrinkage at temperatures up to 60° C., consists in heating above 60° C., stretching, cooling to 60° C. and releasing tension at that temperature.

FILM COATING. H. J. Osterhof (to Wingfoot Corp.). U. S. 2,328,844, September 7. Rubber hydrochloride is coated with a polyvinyl resin.

CLOSURE BANDS. C. O. Pike and J. E. Snyder (to Wingfoot Corp.). U. S. 2,328,845, September 7. A band of rubber hydrochloride is made heat shrinkable by winding while warm around a mandrel and cooling while under tension.

DYEING VINYL RESINS. K. Heymann (to American Viscose Corp.). U. S. 2,328,903, September 7. Shapes molded from vinyl resin polymers are treated with a solution of dye.

COPOLYMERS. H. T. Neher and E. H. Kroeker (to Rohm and Haas Co.). U. S. 2,328,922, September 7. Copolymers are prepared from vinyl alcohol and a methacrylic ester in a water miscible organic solvent, and the reaction product is precipitated with water, dissolved in a solvent containing water and the vinyl ester units are hydrolyzed.

RUBBER HYDROCHLORIDE. A. F. Hardman (to Wingfoot Corp.). U. S. 2,328,976, September 7. Rubber hydrochloride is protected from photochemical deterioration by a reaction product of a dihaloethyl ether and a polyalkylene polyamine in which at least one of the terminal amino groups is primary.

RESINOUS STRUCTURE. J. P. Nielsen (to Woodall Industries, Inc.). U. S. 2,328,992, September 7. A fibrous resin sheet structure is prepared by impregnating a sheet consisting of sisal fibers with a fast-curing thermosetting resin, placing this sheet next to another similar sheet in such a way as to engage fibers of the two and finally subjecting the structure to pressure and sufficient heat to cure the resin.

PLASTICIZER. J. T. Thurston, C. Cob and J. M. Grim (to American Cyanamid Co.). U. S. 2,329,015, September 7. Cellulose derivatives are plasticized with a glycerol ether in which the 3 hydrogens are substituted by an aromatic radical, and members of the group consisting of hydrogen, acyl, aromatic radicals and a radical consisting of a carbon atom attached to carbonyl, ether and 2 methyl groups.

STYRENE COPOLYMER. E. C. Britton, G. H. Coleman and J. W. Zemba (to Dow Chemical Co.). U. S. 2,329,033, September 7. A copolymer of styrene and an unsaturated ester is plasticized with an aromatic di-ether.

PHENOL-ALDEHYDE RESIN. S. S. Gutkin (to Falk and Co.). U. S. 2,329,045, September 7. A modified phenol-aldehyde resin is prepared by forming a condensate of the infusible type by refluxing an aldehyde with a phenol in the presence of an alkali, forming a homogeneous mass with the condensate and an unmodified polyhydric alcohol, and reacting with a polycarboxylic acid.

MOLDED PRODUCTS. F. P. Hunsicker (to Westinghouse Electric and Mfg. Co.). U. S. 2,329,051, September 7. Fibrous material, flameproofed with ammonium or sodium sulfamate, is impregnated with synthetic resin, stacked and molded with heat and pressure into a composite material.

UREA-FORMALDEHYDE. L. Smidth. U. S. 2,329,172, September 7. A molding powder comprising a condensation product of urea and formaldehyde, a cellulose filler and an absorbed liquid.

SHEET MATERIAL. S. P. Lovell (to Beckwick Mfg. Co.). U. S. 2,329,207, September 14. A textile base is treated with a composition of vegetable wax, rubber, beeswax, and polystyrene, polyvinyl acetate or butyl methacrylate, and heated above 130° F. under pressure.

RESIN COMPOSITION. G. Alleman and J. H. Perrine (to Sun Oil Co.). U. S. 2,329,236, September 14. An alkyd resin is prepared by reacting a polyhydric alcohol, a polycarboxylic acid and a metallic salt of a mixture of aliphatic organic acids. *(Please turn to next page)*

MOLDING DEVICE. B. De H. Miller (to Girdler Corp.). U. S. 2,329,288, September 14. An apparatus for molding plastics consisting of a chamber having a movable wall and means for intermittently supplying and ejecting said chamber, and means for varying the frequency of the cycle.

WELTING. G. O'Gorman (to United Shoe Machinery Corp.). U. S. 2,329,290, September 14. A welt for shoes and boots, consisting of plasticized, highly polymerized vinyl chloride.

VINYL RESIN. W. E. Campbell, Jr. (to Carbide and Carbon Chemicals Corp.). U. S. 2,329,456, September 14. A coating composition for smooth surfaces, consisting of a copolymer of a vinyl halide, a vinyl ester of a lower fatty acid and an aliphatic alpha,beta mono-olefinic carboxylic acid.

VINYLIDENE POLYMER. R. M. Wiley (to Dow Chemical Co.). U. S. 2,329,571, September 14. Crystalline vinylidene polymer is heated above its melting point, cooled to below 50° C. rapidly so as to prevent recrystallization, plastically deformed and heated between 55 and 115° C.

WIRE COATING. A. O. Blades (to General Cable Corp.). U. S. 2,329,583, September 14. Conducting wires are coated with an insulating and protecting coating of vinyl chloride-acetate copolymer plasticized with a mixture of hydrogenated methyl abietate and an ester having 2 hydrocarbon chains of at least 8 carbon atoms each.

WOOL TREATING. E. P. Johnstone, Jr., and W. J. van Loo, Jr. (to American Cyanamid Co.). U. S. 2,329,622, September 14. Felting and shrinking of wool is reduced by impregnating a woolen fabric with an aqueous solution of melamine-formaldehyde resin, followed by heating until the resin is cured to a substantially water insoluble state.

COATINGS. R. C. Swain and P. Adams (to American Cyanamid Co.). U. S. 2,329,663–4, September 14. Coating compositions containing manila or kauri resin and melamine-formaldehyde resin which has been alkylated with an alcohol containing at least 4 carbon atoms.

CELLULOSE ESTERS. C. Dreyfus, R. D. Rowley, M. E. Martin, C. I. Haney, G. W. Seymour and B. B. White (to Celanese Corp. of America). U. S. 2,329,704–5–6–17–18–30, September 21. Organic esters of cellulose are prepared by esterifying cellulose with a lower fatty acid anhydride in the presence of an inorganic acid such as sulfuric or phosphoric, neutralizing the catalyst, adding water and ripening the ester to the desired solubility in several stages by the addition of ripening agents such as magnesium, calcium, zinc, etc., compounds, at least one stage of the ripening being effected in the absence of catalyst.

CELLULOSE ETHERS. A. E. Broderick (to Carbide and Carbon Chemicals Corp.). U. S. 2,329,741, September 21. Acetal-like derivatives of water-soluble partially alkylated cellulose derivatives are prepared by reacting with keto-aldehydes and removing excess water.

STABILIZER. L. J. Stage and M. T. Harvey (to Harvel Research Corp.). U. S. 2,330,087, September 21. A composition of polyvinyl chloride or chloride-acetate copolymer and a plasticizer are stabilized against fading by incorporation of a reaction product of tertiary alkyl urea having from 4 to 6 carbon atoms in the tertiary alkyl group and a saturated fatty acid having 12 to 18 carbon atoms in the molecule.

GASKET MATERIAL. W. F. Bernstein and T. F. Mika (to Victor Mfg. and Gasket Co.). U. S. 2,330,106, September 21. A sheet of compressible gasket material of uniform composition and density, comprising asbestos fiber, a binder of petroleum oil, carbon black and bentonite, and a coating composed of phenol-aldehyde China-wood-oil resin and graphite.

POLYSTYRENE MOLDINGS. R. R. Bradshaw (to Dow Chemical Co.). U. S. 2,330,108, September 21. A molded object having a nacreous sheen, consisting of polystyrene and a sodium, potassium or magnesium salt of a higher aliphatic acid.

FILTERING. C. I. Haney (to Celanese Corp. of America). U. S. 2,330,211, September 28. The filtering of viscous solutions of cellulose derivatives is improved by the addition of a fibrous material.

PHENOL-ALDEHYDE RESINS. J. V. Hunn (to Sherwin-Williams Co.). U. S. 2,330,217, September 28. An alkyl phenol is reacted with aqueous formaldehyde in the presence of acid catalyst and a small amount of a surface active wetting agent at a temperature of 180–210° F. to give a resin.

MOLDED ARTICLE. T. C. Morris (to B. B. Chemical Co.). U. S. 2,330,233, September 28. An article capable of being lacquered is molded from a fibrous material mixed with thermosetting resin by first preparing a preform, coating with a thermosetting resin and a base for the lacquer, and finally curing the thermosetting resin.

CELLULOSE DERIVATIVES. A. E. Broderick (to Carbide and Carbon Chemicals Corp.). U. S. 2,330,263, September 28. A fatty acid ester of an hydroxyalkyl cellulose is prepared by pretreating a dry hydroxyalkyl cellulose with a lower fatty acid anhydride, and reacting with an esterifying bath containing a catalyst and a lower fatty acid anhydride.

SHEET MATERIAL. B. P. Hazeltine and E. R. Derby (to Monsanto Chemical Co.). U. S. 2,330,282, September 28. Thermoplastic sheets are made by extruding a solution of the resin into the form of a continuously moving web and continuously polishing the surfaces by evaporating a portion of solvent from both surfaces, condensing the evaporated solvent on a pair of polishing surfaces and pressing the web against them.

CURING CATALYSTS. H. Hönel (to Reichold Chemicals, Inc.). U. S. 2,330,286, September 28. An alkylated resol is hardened by addition of an acidic partial phosphoric ester obtained by reacting phosphorous pentoxide with castor oil in an amount insufficient to give the triester.

SAFETY GLASS. J. D. Ryan and G. B. Watkins (to Libbey-Owens-Ford Glass Co.). U. S. 2,330,313, September 28. Glass plates are laminated with a sheet of ethyl cellulose by means of an ethyl cellulose adhesive.

NON-WOVEN FABRIC. G. L. Schwartz (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,330,314, September 28. A low wet strength non-woven web of fibers is treated with polyvinyl alcohol solution and then impregnated with an aqueous solution of alkali metal hydroxide.

COATING. M. M. Brubaker (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,330,333, September 28. A coating of crystalline synthetic linear polyamide, heat stabilized by a fusible non-heat-hardening phenolic resin selected from the class consisting of *p*-tertiary butyl phenol-formaldehyde and *o*-cyclohexylphenol-formaldehyde resins, by melting a rod comprising the polyamide and resin in a non-oxidizing flame, projecting molten material by means of pressured gas against the object.

DRYING ACCELERATORS. M. E. Cupery (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,330,337, September 28. An air-drying coating composition comprising an oil-modified alkyd resin is accelerated by means of an aliphatic unsaturated ketone having a carbonyl group conjugated with an ethylenic double bond.

MIXTURE OF POLYMERS. D. E. Henderson (to B. F. Goodrich Co.). U. S. 2,330,337, September 28. A composition comprising a mixture of a vinyl halide and a copolymer of a butadiene-1,3,hydrocarbon and an acrylic nitrile.

(Please turn to next page)

MOLDING APPARATUS. O. W. Marsh (to General Industries Co.). U. S. 2,330,369, September 28. An apparatus for molding plastic articles which are oppositely tapered in both directions proceeding from an intermediate region of greatest cross section.

ADHESIVE. A. E. Hughes, H. B. Browne and H. F. Roderick (to Wyandotte Chemicals Corp.). U. S. 2,330,428, September 28. Calcium carbonate, casein or alpha protein and water are kneaded to produce a homogeneous mixture of high plasticity.

STYRENE-TYPE POLYMERS. H. P. Staudinger (to Distillers Co., Ltd.). U. S. 2,330,527, September 28. A mixture of styrene and styrene polymers is polymerized in the presence of an ester of crotonic acid.

HELMET. E. E. Oestrike. U. S. 2,330,732, September 28. A scalp-treating helmet is formed by applying a tight-fitting covering to the head, and coating with a rapid-setting plastic material.

RUBBER-LIKE POLYMER. M. B. Chittick and A. F. Schlandt (to Pure Oil Co.). U. S. 2,330,798, October 5. A vulcanized rubber-like composition is prepared by reacting sulfur, an oil such as perilla, castor, tung, linseed or bodied fish, and hydrocarbon polymer resulting from contacting of diolefin-containing, light, cracked, hydrocarbon distillates with catalytic adsorptive clay.

RESIN SURFACED WOOD. J. V. Hunn (to Sherwin-Williams Co.). U. S. 2,330,826, October 5. Cocobola wood having natural phenolic-reacting constituents which, when treated with an aldehyde, form a condensation product, the process consisting in subjecting the wood to an aqueous bath of aldehyde solution, containing a catalyst, and finally reacting the product to form the cured resin *in situ*.

PHENOLIC RESIN. E. B. Kester (to Koppers Co.). U. S. 2,330,827, October 5. A composition comprising the resin product obtained by heating and reacting a phenol with a naphthalene-formaldehyde reaction product.

CELLULOSE ETHER. A. R. Gabel and F. L. Taylor (to Dow Chemical Co.). U. S. 2,331,090, October 5. A cellulose ether is plasticized with a beta-aryloxy,beta,1-chloro dialkyl ether.

COMPOSITION. R. S. Ritchie (to Dow Chemical Co.). U. S. 2,331,095, October 5. A fusible composition consisting of a cellulose ether, a plasticizer and a natural resin compatible in the molten state with the cellulose ether, the composition being viscous and adhesive at 150° C.

COMPOSITION. H. A. Bruson (to Resinous Products and Chemicals Co.). U. S. 2,331,169, October 5. An esterified phenol nuclearly substituted by at least one acyloxymethyl group of not over 8 carbon atoms is reacted with a drying oil fatty acid until the original acyl group has been replaced.

STYRENE COPOLYMERS. E. C. Britton, G. H. Coleman and J. W. Zemba (to Dow Chemical Co.). U. S. 2,331,263, October 5. A mixture of styrene and a neutral unsaturated ester composed of a carboxylic acid containing less than 10 carbon atoms in the molecule, esterified with an alcohol such as allyl, 2-chloro-allyl and 2-methyl allyl is subjected to polymerizing conditions in the presence of an inert solvent.

RESINOUS COMPOSITION. R. D. Lowry (to Dow Chemical Co.). U. S. 2,331,273, October 5. A polymerized vinyl aromatic compound containing a plasticizer.

CHLORINATED RUBBER HYDROCHLORIDE. W. M. Kutz (to Raolin Corp.). U. S. 2,331,327, October 12. A dilute solution of rubber hydrochloride is treated with chlorine at 250° C. under the influence of ultraviolet light radiation.

PLASTIC. L. P. Kyrides (to Monsanto Chemical Co.). U. S. 2,331,328, October 12. A plastic composition comprising a polyvinyl acetal resin and an ester of hydroxycyclohexanone.

CELLULOSE PLASTIC. L. P. Kyrides (to Monsanto Chemical Co.). U. S. 2,331,330, October 12. An ester or an ether of cellulose is modified with a carboxylic acid ester of a hydroxycyclohexanone.

AMINOPLAST. G. F. D'Alelio (to General Electric Co.). U. S. 2,331,377, October 12. A heat curable aminoplast is modified with at least one compound such as salt of a nuclearly poly-substituted carbocyclic compound and is reactive with aldehydes.

ZEIN COMPOSITE. R. R. Sitzler (to Celanese Corp. of America). U. S. 2,331,434, October 12. A film-forming solution contains zein, a solvent composed of a mixture of ethylene formal and methyl alcohol, urea and formaldehyde.

CONDENSATION PRODUCT. G. Widmer and W. Fisch (Ciba Products Corp.). U. S. 2,331,446, October 12. An adhesive comprising a water-soluble, heat-hardenable condensation product obtained by condensing aldehyde, a triazine substituted with hydroxyl, halogen, alkyl, aryl or aralkyl, and urea, thiourea, cyanamide, dicyandiamide, dicyandiamidine or aniline.

PLASTIC COMPOSITION. K. E. Marple and F. A. Bent (to Shell Development Co.). U. S. 2,331,614, October 12. A composition of cellulose acetate, a cyclic ketal from glycerol, and an aliphatic cyclic monoketone containing not less than 8 nor more than 12 carbon atoms.

MOLDED ARTICLES. J. R. Hobson (to Hartford-Empire Co.). U. S. 2,331,688, October 12. Hollow articles are formed from organic plastic materials by means of injection molding under heat and pressure.

MOLDED ARTICLES. W. H. Kopitke (to Hartford-Empire Co.). U. S. 2,331,702, October 12. Hollow articles are formed from plastic materials by application of heat and pressure to soften the material in an injection device, injection molding a seamless blank of material in a mold unit, removing the blank before hardening and blowing into a seamless hollow article in a blow mold.

THIN SHEETING. G. F. Nadeau and E. H. Hilborn (to Eastman Kodak Co.). U. S. 2,331,715, October 12. Thin transparent cellulose organic acid ester sheeting having on at least one surface an adherent deposit of fine particles of prolamine whereby cohesion is prevented.

PHOTOGRAPHIC FILM. G. F. Nadeau and C. B. Starck (to Eastman Kodak Co.). U. S. 2,331,717, October 12. A photographic film having low dye retention subbing layers is comprised of a cellulose ester support, an emulsion layer adapted to receive a colored image, and a subbing layer composed of a mixture of gelatin and a polyvinyl organic acid ester, a polyacrylic ester or a polyvinyl acetal.

FILM. J. W. Raynolds and W. M. Kutz (to Raolin Corp.) U. S. 2,331,717, October 12. A film for container closures consists of chlorinated rubber hydrochloride.

RUBBER HYDROCHLORIDE FILM. J. E. Snyder (to Wingfoot Corp.). U. S. 2,331,742, October 12. A non-waxy rubber hydrochloride film is laminated to a wax-containing rubber hydrochloride film by means of heat.

PHENOLIC RESINS. R. C. Swain and P. Adams (to American Cyanamid Co.). U. S. 2,331,744, October 12. Oil soluble phenolic condensation products are prepared by heating an alkyl phenol, having an alkyl group of at least 3 carbon atoms, with formaldehyde solution containing melamine, at reflex temperature, and removing water by distillation.

s cold up yonder. Even the mechanical devices handled by men ho fly the upper airways must be ade of especially selected mateals to withstand the low temperares. This mobile microphone, degned for aviation communication, a good example of the care the gnal Corps uses in selecting the ht material for a specific job.

e handle and housing of this microone are molded from ETHOCEL, plastic that does not become ittle or fragile when subjected to vere cold. It possesses extremely high impact strength in sub-zero temperatures, which protects it from damage if dropped.

In selecting material for this, and many other types of essential war equipment, there is always the question: Does it lend itself readily to mass production? ETHOCEL is so easy to fabricate that it actually speeds production and is an economy factor as well. Again in these microphones a Dow plastic does a more efficient job, meeting all the requirements of a difficult application.

Microphone handle molded of low temperature, impact resistant Ethocel. Six metal inserts are used in a single cavity die.

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ETHOCEL

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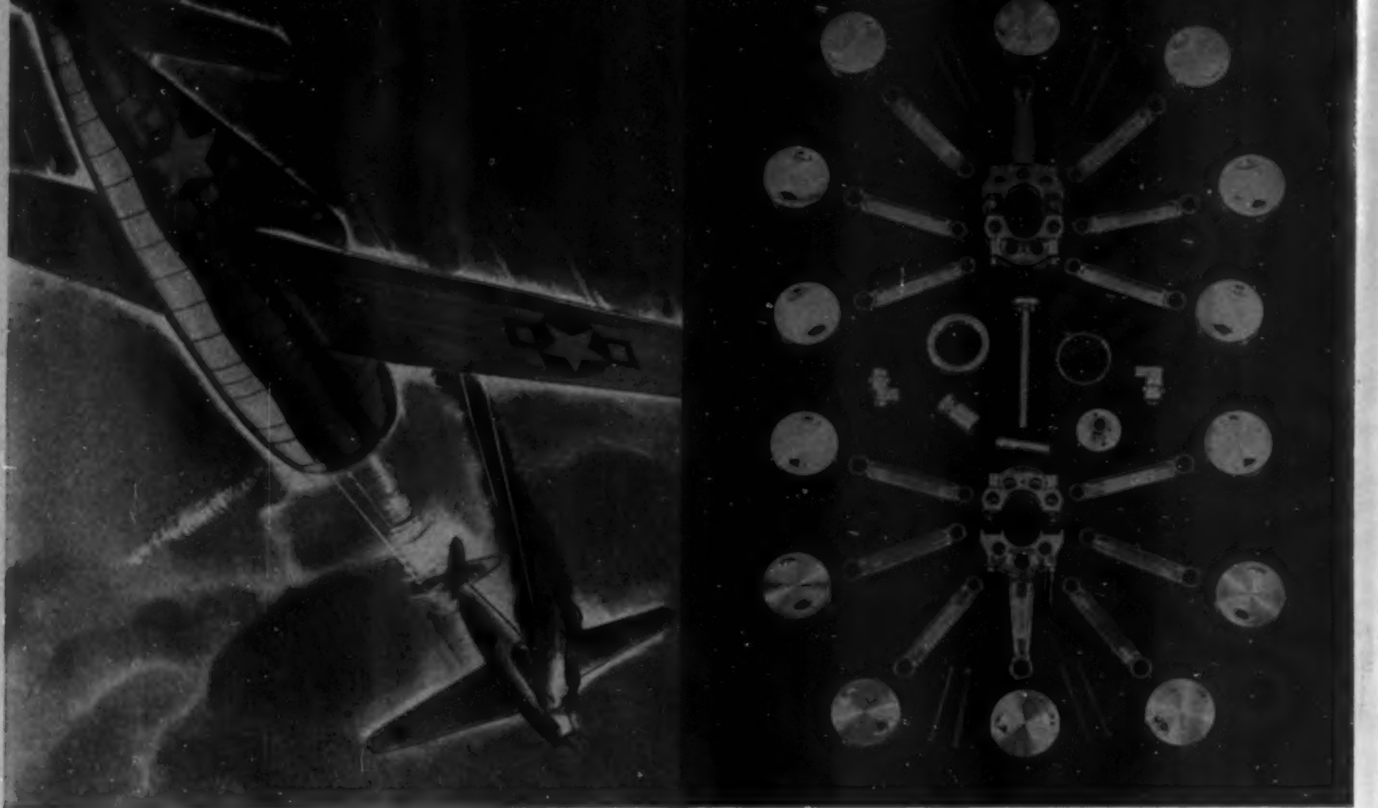
CHEMICALS INDISPENSABLE TO INDUSTRY AND VICTORY

IT'S A FIGHT TO THE FINISH!



WHEN a Hellcat pilot eases up on the bridle of the 2000 horsepower packed into his Pratt-Whitney engine and goes tearing away to administer a dose of sudden death to some little stinking son of a Sinking Sun, a small matter like the coefficient of friction between operating parts of that engine becomes enormously important.

Not many months ago this coefficient of friction, between parts whose tolerances had to be held to within thousandths of an inch, was a limiting factor in the maximum performance of our most advanced high-output aircraft engines. It wasn't that modern finishing methods and materials couldn't produce the mirror-like finishes required—on the contrary the finishes obtained were so perfect that they had no affinity for the engine lubricant—in short, those mirror surfaces shed engine oil like water rolls off a duck's back. The inevitable result was excessive friction heat—a condition that spelled TROUBLE in capital letters.

Licking this problem was no cinch—mirror-like finishes had to be maintained but certain profilometer requirements also had to be met. This meant developing a buffing composition that not only polished but also engrained the metal surfaces with millions of microscopic channels which would retain enough lubricating oil under every operating condition, to provide a protective oil film on every vital part. A McAleer *tailored-to-the-job* greaseless type composition was the answer—a composition of such dependable uniformity and exceptionally controlled abrasive diffusion, that it met every prescribed Micron finish requirement demanded by Aircraft Specifications.

This need for perfection is nothing new to McAleer. We are well aware that this is a fight to the finish . . . even to the "finish" of a vital aircraft engine part. Because *quality-controlled* finishing materials are the products—not the sideline of McAleer, this company is qualified by years of practical experience and unusual abilities to aid you in solving your most vital finishing problems. Whether they involve metals, plastics, or both, let us *start at the finish.*

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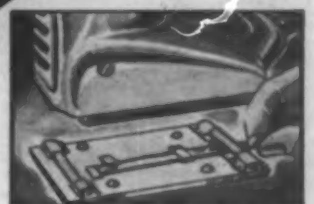
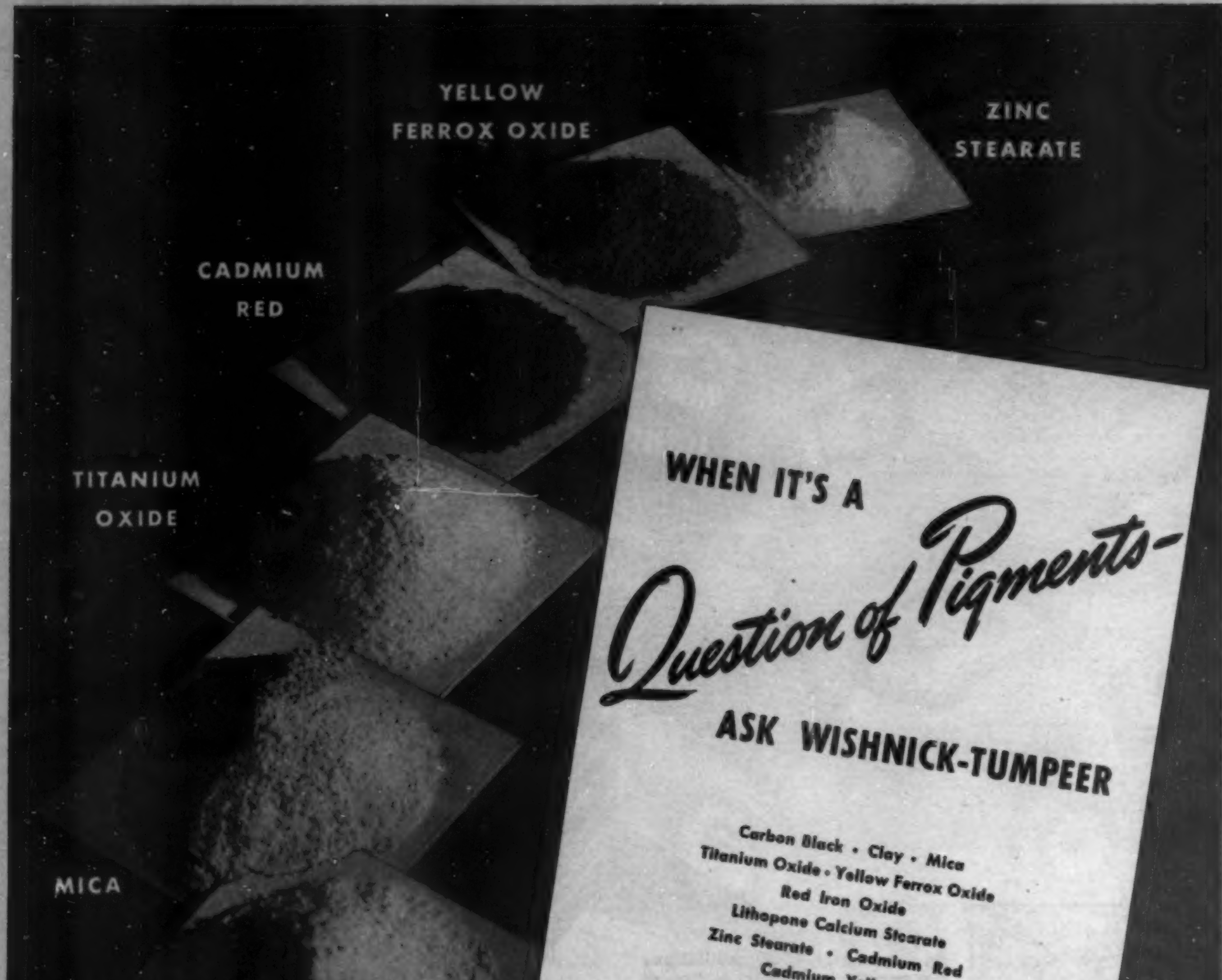
MANUFACTURING CO.

Manufacturers of Quality Controlled Finishing Materials

ROCHESTER, MICHIGAN


ORBITAL MOTION
MAKES STERLING SANDING BETTER THAN HAND OR ORDINARY MACHINE SANDING!




YELLOW FERROX OXIDE
ZINC STEARATE
CADMIUM RED
TITANIUM OXIDE
MICA
CARBON
WHEN IT'S A
Question of Pigments-
ASK WISHNICK-TUMPEER
Carbon Black • Clay • Mica
Titanium Oxide • Yellow Ferrox Oxide
Red Iron Oxide
Lithopone Calcium Stearate
Zinc Stearate • Cadmium Red
Cadmium Yellow
Chromium Green Oxide
Witcarb (Precipitated Calcium Carbonate)
Stearite (Hydrogenated Stearic Acid)
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CHEMICALS • PIGMENTS • ASPHALTUMS

Start Here.. ..to Simplify your Fastening Jobs ..to Find the Best Means of Doing It

WHERE To Use WHAT Parker-Kalon Self-tapping Screw

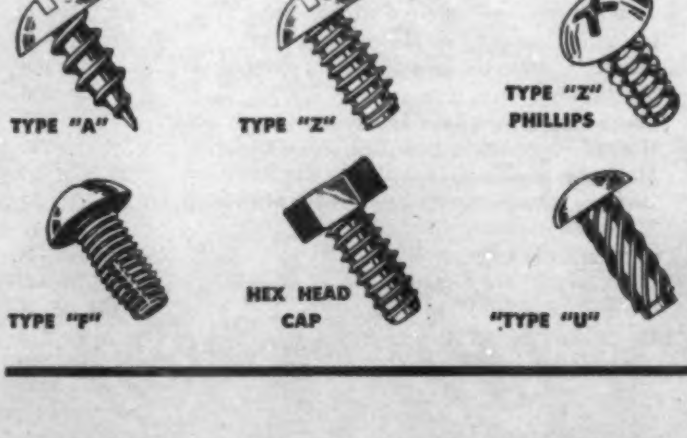
KIND OF MATERIAL	TYPE OF SCREW: Type A	Type Z	Type Z (18-8 stainless steel)	HEX CAP	Type F	Type F (corrosion-resisting steel)	Type F-Z	Type U	Type 21
SHEET METAL .015" to .050" thick (Steel, Brass, Aluminum, Monel, etc.)					Not recommended	Not recommended		Not recommended	
SHEET STAINLESS STEEL .015" to .050" thick			Not recommended				Not recommended	Not recommended	Not recommended
SHEET METAL .050" to .200" thick (Steel, Brass, Aluminum, etc.)	Not recommended		Not recommended				Not recommended		Not recommended
STRUCTURAL STEEL .200" to ½" thick	Not recommended	Not recommended	Not recommended				Not recommended		Not recommended
CASTINGS (Aluminum, Magnesium, Zinc, Brass, Bronze, etc.)	Not recommended						Not recommended		Not recommended
CASTINGS (Grey Iron, Malleable Iron, Steel, etc.)	Not recommended	Not recommended	Not recommended	Not recommended		Not recommended	Not recommended		Not recommended
FORGINGS (Steel, Brass, Bronze, etc.)	Not recommended	Not recommended	Not recommended	Not recommended	Not recommended	Not recommended	Not recommended		Not recommended
PLASTICS: PHENOL FORMALDEHYDE Molded: Bakelite, Durez, etc. Cast: Catalin, etc Laminated: Formica, Textolite, etc.	Not recommended								Not recommended
PLASTICS: UREA FORMALDEHYDE Molded: Plaskon, Beetle, etc	Not recommended	Not recommended	Not recommended	Not recommended	Not recommended	Not recommended			Not recommended
PLASTICS: CELLULOSE ACETATES and CELLULOSE NITRATES: Tenite, Lumarith, Plastacele, Celluloid, Pyralin, etc	Not recommended								Not recommended
PLASTICS: ACRYLATE and STYRENE RESINS: Lucite Plexiglas, Styron, etc	Not recommended								Not recommended
PLYWOOD, Resin Impregnated: Compreg, Pregwood, Armstrong, etc.									Not recommended
ASBESTOS and other compositions: Ebony Asbestos, Transite, Marinite, etc.					Not recommended	Not recommended		Not recommended	Not recommended

NOTE: "NOT RECOMMENDED" does not necessarily signify that the type of Screw cannot be used for the purpose. It denotes that it is not the type of Self-tapping Screw which will generally give the best results in that material.

Can you use the simpler, Parker-Kalon Self-tapping Screw method? Can you eliminate tapping and nut-running, eliminate inserts, avoid rejects, improve fastening security? Can you save time and lower costs? This chart shows why the answer is YES, in 7 out of 10 cases – shows that the *complete* line of Parker-Kalon Self-tapping Screws covers practically the entire field of your fastening needs, for metal or plastics.

The chart also shows why a P-K Assembly Engineer can make unbiased recommendations. He has many different types of Screws, from which to select a Screw *exactly* suited to your special requirements.

Study this chart and *question every fastening*... at the drafting board or on the assembly line. Find out if you can use the simple P-K method before you put up with one more difficult, more costly. Ask for a P-K Assembly Engineer to help you search out *all* opportunities to apply P-K Self-tapping Screws, or submit details of your fastening for recommendations. Parker-Kalon Corporation, 190-200D Varick St., New York 14, N. Y.



PARKER-KALON

Quality-Controlled

SELF-TAPPING SCREWS

MACHINERY *and* EQUIPMENT

★ REED-PRENTICE CORP., WORCESTER, MASS., HAS announced two new additions to its line of injection equipment —a 16-oz. and a 22-oz. capacity injection molding machine. The company states that these 2 machines have been newly designed from the ground up. The frame construction is said to be improved through the use of heavy steel plates for stressed members. Push buttons control the mold adjustment which is obtained by moving the link mechanism within the frame by means of 2 large diameter screws driven by an electric motor. This latter construction is patented.

A new type of mold-locking mechanism provides a mold-closing pressure of 600 tons, and at the same time it allows for a maximum of 16 in. of die movement which, of course, can be easily shortened for operating thin molds. All movements are controlled automatically from a newly designed timing panel, but manual operation is obtainable instantaneously. Both the die plate and plunger can be stopped immediately at any position. Safety doors with both hydraulic and electric interlocks are designed so that they roll on sturdy rails, a method that insures positive safe operation. The die plates are so arranged that automatic ejection can be provided at the center and at the 4 corners.

The heater is so designed that it can be removed easily. All piping, electrical controls and hydraulic equipment with the exception of the pumps, are mounted outside the machine. This arrangement allows for easy accessibility. In general design the 16- and 22-oz. machines are similar—the only difference lying in the size of the heating chamber and the injection cylinders.

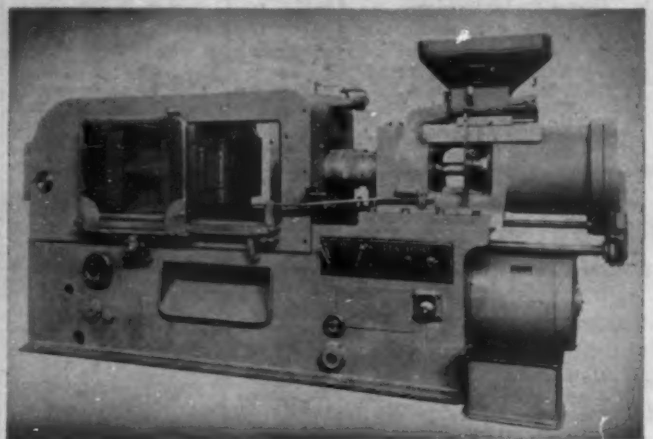
To complete the new design on these machines, a water cooling system for molds has been built as an integral part of the equipment. All valves controlling this cooling system are on the front of the machine so that the operator has easy access to them at all times.

Except as regards the ounces molded per shot, the maximum shots per hour and pounds per square inch of pressure exerted on the material, the specifications for the 16- and 22-oz. machines are exactly alike:

Plasticized material per hr., lb	100
Capacity of feed hopper, lb	80
Time required for injection stroke, sec	1.6
Size of die plates, in	30 × 30
Clearance between top and bottom frame members, in	29
Opening in top frame member, in	18 × 46
Opening in bottom frame member, in	18 × 46
Mold opens, in	16
Maximum die height, in	20
Minimum die height, in	8
Maximum casting area in mold, sq. in	150
Mold closing pressure, tons	600
Power consumption of heater at max. capacity, kwh	7
Length by width by height, in	210 × 54 × 79
Weight, tons	14
Motor required, 1200 rpm., h.p	40

The 16-oz. machine molds 16 oz. per shot, a maximum of 180 shots per hr., and exerts a pressure of 27,000 p.s.i. on the material. The 22-oz. unit molds 22 oz. per shot, a maximum of 150 shots per hr., and exerts a pressure of 28,000 p.s.i. on the material.

★ A NEW 16-OZ. DE MATTIA INJECTION MOLDING machine has been designed by the Brosites Machine Co., New York, N. Y. This machine, while new in design, incorporates all the refinements of the other units manufactured by this company. These include a toggle-type mold clamping mechanism, a self-contained hydraulic accumulator and a method of adjusting the mold closing mechanism by means of one center screw.



An important detail of the toggle clamping mechanism is the manner in which the toggle members roll on their end faces thus eliminating the need for wrist pins, and take the full clamping pressure in shear. However, this pressure is taken in compression on the end faces of the hardened toggle members themselves. The rolling action of the toggle members as they straighten out, permits a very high clamping pressure on the order of 600 tons.

The built-in hydraulic accumulator enables the operator to obtain very fast injection strokes without the use of excessively large pumps and motors. This feature lends itself to economy in operation since the molder is permitted to idle during the dwell period of the cycle.

Specifications as shown below have been taken from actual performance data. One very important figure is the "plasticizing capacity" which was shown to be on the order of 175 lb. of thermoplastic material per hour. Another specification worth noting is the "maximum projected area of molded parts." Of course, this figure must include the area of the runners. According to the Brosites Machine Co., their new 16-oz. machine has ample clamping pressure to allow for a total projected area of molded parts and runners of approximately 168 square inches.

Material per shot, oz	16
Injections per hr	16–180
Time for complete injection stroke, sec	4.8
Injection time to fill mold, sec	3
Maximum projected area of molded parts, sq. in	168
Mold closing force, tons	600
Plasticizing capacity per hr., lb	175
Horsepower of motor furnished	30
Maximum mold size, in	23.5 × 30
Distance between mold faces (stroke) when open, in	14
Maximum die space, in	17
Minimum die space, in	8
Injection unit pressure, p.s.i	30,000
Floor space required, in	164 × 34
Height over hopper, ft	6.5
Approximate weight, tons	10

PUBLICATIONS

Write directly to the publishers for these booklets. Unless otherwise specified, they will be mailed without charge to executives who request them on business stationery. Other books will be sent postpaid at the publishers' advertised prices.

The Chemistry of Large Molecules

by R. E. Burk and Oliver Grummitt, Editors

Interscience Publishers, Inc., New York, 1943

Price $3.50 **313 pages**

Eight lectures on high polymers at Western Reserve University are assembled in this book which is Volume I of a series entitled "Frontiers in Chemistry." The subjects and authors are as follows: "Mechanism of Polyreactions" and "Investigations of High Polymers with X-Rays" by H. Mark; "Colloidal Behavior of Macromolecular Materials" and "The Ultracentrifuge and Its Applications" by E. O. Kraemer; "Elastic-Viscous Properties of Matter" by A. Tobolsky, R. E. Powell and H. Eyring; "Electrical Properties of High Polymers" by R. M. Fuoss; "Chemistry of Vinyl Polymers" by C. S. Marvel; and "Chemistry of Cellulose and Its Derivatives" by Emil Ott.

This book is highly recommended to anyone interested in reviewing the organic and physical chemistry of high polymers or obtaining a background of information concerning this field. Both the manner of presentation of the subject matter by the authors and the format used in its publication make the reading of this book a profitable pleasure. G.M.K.

Handbook of Chemistry and Physics—27th Edition

by Charles D. Hodgman, Editor-in-Chief

Chemical Rubber Publishing Co., Cleveland, Ohio, 1943

Price $4.00 **2553 pages**

The 1943–1944 edition of this handbook again brings home the fact that science marches on in spite of war. Over 100 pages of new composition have been added to this volume which furnishes the latest available fundamental data in the fields of chemistry, physics and mathematics. Chemists and engineers engaged in work on plastics well know the rapidity with which technical information can become obsolete. Hence they can especially appreciate the important job which the editor, collaborators and publishers of this handbook are doing in supplying them annually with up-to-date data in ready reference form. G.M.K.

Protective and Decorative Coatings, Vol. III

prepared by a staff of specialists under the editorship of Joseph J. Mattiello

John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y.

Price $7.50 **830 pages**

This is the third of a series of 4 books dealing with the protective and decorative coating industry. This volume dwells particularly on manufacture and uses of colloids, oleoresinous vehicles and paints, water and emulsion paints, lacquers, printing inks, luminescent paints and stains. The authors have endeavored to give a general and comprehensive picture that would organize the scattered body of facts and theories on paint technology into a coherent whole. With extensive reference to the original literature, numerous illustrative drawings and photographs, this material should be a valuable reference and a guide for many years to come to anyone interested in the protective coating industry.

★ THE 830TH ARMY AIR FORCE SPECIALIZED DEpot, 3300 Jackson Ave., Memphis 1, Tenn., has published a 32-page catalog of material of the U. S. Army Air Forces which is available to manufacturers or their suppliers under existing regulations. This profusely illustrated booklet was issued in the belief that it was essential to the successful prosecution of the war and for protection against shortages of needed materials, that all property not immediately needed by the Army Air Forces be returned to industry for use directly or indirectly in manufacturing or other activities connected with the war.

★ HERCULES POWDER CO., WILMINGTON, DEL., has published a booklet setting forth the latest data on the company's series of esters made from hydrogenated rosin. These non-oxidizing Staybelite esters are chemically described as the glycerin, mono-, di- and tri-ethylene glycol esters of hydrogenated rosin, and they are finding their widest use in the formulation of adhesives based on rubber, ethyl cellulose, polybutene, chlorinated rubber and nitrocellulose.

A technical booklet issued by the same company reports on the use of Lewisol maleates in protective coatings. The Lewisols are described as hard resins made by modifying rosin esters with maleic alkyd compounds in common with other hard resins of the rosin ester group. Primarily they are intended for compounding with film-forming materials such as the cellulose derivatives, or with drying oils to achieve gloss and hardness. A table giving the viscosities of 22 stored Lewisol No. 33 varnishes is included.

★ "HOW TO MAINTAIN ELECTRIC EQUIPMENT" IS the title of a book published recently by the General Electric Co., Schenectady, N. Y., and retailing for $1.75 a copy. More than 500 illustrations, dozens of new tables, many hitherto unpublished charts and an easy-to-use index combine to make this book a "must" for engineers intent upon keeping their equipment in top-notch condition. Preventive-maintenance schedules and trouble-shooting charts are included on nearly all types of apparatus. Photos and diagrams give suggestions on what to do to get maximum performance and longest life from each machine. The book is designed for quick reference.

★ RHODE ISLAND LABORATORIES, INC., WEST WARwick, R. I., has issued a booklet describing its "Violite" luminescent pigments. The pocket-sized book also includes a nomenclature of important technical verbiage used in the industry.

★ THE SIXTH EDITION OF A HANDBOOK ON "PRINciples and Practice of Flow Meter Engineering" by L. K. Spink has been published by Foxboro Co., Foxboro, Mass., and can be obtained by sending $3 to the above address. The 232-page book is profusely illustrated with photographs, diagrams and curves, and it contains all the tables and formulas needed for ordinary liquid or gas flow computation. In the Liquid Section, methods for determining compressibility factors of liquids at temperatures near critical, a new method of correlating temperature expansion data on petroleum oils, and a short-cut method of correcting for viscosity are featured. The Gas Section suggests methods of correcting for viscosity effects.

★ THE TECHNICAL SERVICE SECTION, INDUSTRIAL Salvage Branch, Salvage Div., WPB, has just compiled the first comprehensive practical manual on industrial salvage. Most of the 245 pages are filled with information of a "how-to-do-it" nature. There are 2 chapters on organizing and planning the salvage department, 3 on the administrative factors, 12 on methods of handling metal scrap (finding, identifying, segregating, collecting, reclaiming, storing, selling, etc.), 3 on nonmetallic waste, 7 case histories, a 17-page compilation of practical hints for handling specific waste materials, and a 9-page index. The well-illustrated volume was prepared and edited by an editorial board of practical industrial salvage engineers and business paper editors. A copy can be obtained for 50 cents by writing the Superintendent of Documents, Government Printing Office, Washington, D. C.

WASHINGTON ROUND-UP

Current news, Government orders and regulations affecting the plastic industry, with analysis of the plastic situation as prepared by R. L. Van Boskirk, our Washington editor

Vinyl development threatened by government policy

"Keep your eye on the vinyls!" A plastics expert who probably knows as much about the over-all plastics picture as any plastics man in America passed us that tip several months ago.

Today vinyls are used chiefly for coatings, film coverings, tubing, wire and cable insulation, measuring instruments and in rigid sheet applications. Its uses are limited to these principal categories only because there are not enough facilities to make it available for many other purposes. Tomorrow, vinyls could revolutionize the entire plastics picture. Their possibilities seem unlimited yet few people are aware of their potentiality. The idea that they will compete only for rubber-like applications should be promptly dismissed. In addition to elastomeric properties, their electrical qualities, chemical resistance and dimensional stability are exceptional. Furthermore they can be made flameproof by proper choice of plasticizers. They can be compression or injection molded, calendered, cast, extruded, laminated, press plate polished—used in solution, powder, sheets, rods or tubes. Their transparency and color adaptability add to their advantages in plastic applications and put them far out in front of rubber for many purposes. Today the production of vinyl resin is more than five times that of 2 years ago. There are probably 30 or more different types now in commercial use. Only the producers themselves know how far they expect to go in developing more types immediately following the war.

Just a small list of future applications include auto and household upholstery, screens, pocketbooks, wall covering, table covers, floor tiling, elastic fiber for girdles and surgical bands, stockings, wire and cable, shoe soles, etc. Packaging may be revolutionized because of vinyl's capacity to protect against moisture, oil and chemicals. Today it can be made so that it is scarcely distinguishable from foil. The Army's vinyl resin gun covers have been one of the war's colorful new developments. Its use in surgical bands where it is superior to rubber is particularly striking. It holds without binding when applied to such uses as arch braces. Another noteworthy application is for unbreakable transcriptions and recordings—it is possible that vinyls may supplant the present type of ordinary phonograph records when they become more available. It is useless to guess what may happen when the war is over, and competition, research and good old-fashioned marketing and selling all join hands and put the vinyls into competition for applications that now are made of rubber, leather, metal, wood or other materials.

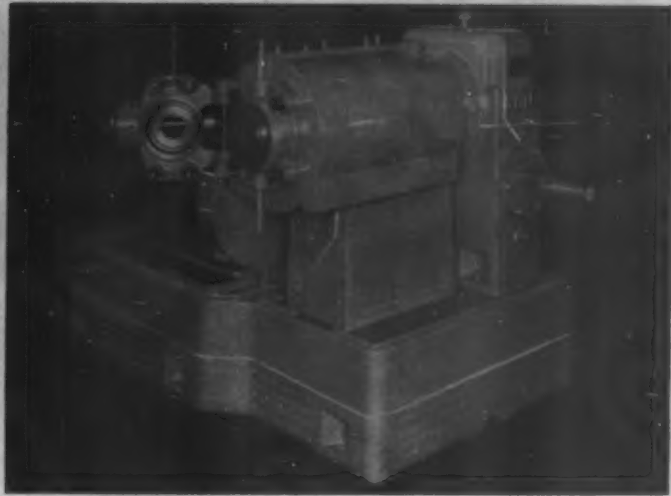
Unfortunately, there are some big flies in the vinyl ointment—flies that bear close resemblance to such things as the U. S. Government, Rubber Reserve Co., Office of the Rubber Director and even the Army and Navy. There is also a most peculiar situation wherin vinyls are manufactured solely by synthetic rubber manufacturers or companies that are large suppliers of synthetic rubber raw materials. The vinyl industry is comparatively new—the rubber industry is old, big and powerful. But rubber at this date is the vinyl industry's most potent competitor. A large rubber company is operating a government subsidized synthetic rubber plant on one side of the street—on the other side it is operating its own vinyl plant without government aid. Yet the products from both plants are in direct competition. When that same rubber company wants to manufacture such products as cable insulation, raincoats, coatings, rubber gloves, etc., it may buy synthetic rubber from the subsidized plant it operates for the government in competition with its own vinyl which is manufactured across the street.

Although the fact is not admitted officially, pressure is being applied constantly by the ORD, Army and Navy to substitute subsidized synthetic rubber for vinyl in all possible application. This situation together with the added difficulty of competing with a subsidized product may well knock the vinyls for a loop and delay development of this most utilitarian product. Reasons for pressure to substitute government rubber for vinyls in government contracts are quite obvious. Apparently there is more synthetic rubber coming out of the copolymer plants than can be absorbed by the auto tire processing plants. Many of the tire plants were changed over early in the war and are now making ordnance items. Furthermore, more men are needed to make tires from synthetic rubber than were required when crude rubber was used. But the ORD, Army and Navy insist that their copolymer plants must run full blast. They fear criticism if it should be learned that any are closed down while the country is clamoring for tires or if it should be learned that the entire synthetic rubber program was expanded beyond actual needs. Consequently, they are trying to find outlets for every ounce of subsidized Buna S produced and in some cases actually encouraging non-essential civilian uses although less critical substitutes are available. This particular situation is tough on vinyl producers because they stepped into the breach when the rubber situation was darkest in 1942 at a sacrifice of their normal markets—produced a product that frequently did a better job than rubber—and are now threatened with the boot. Few persons will protest if the subsidy helps to put auto tires on every auto in America as soon as practicable, but like most subsidies, this one is also being used for other purposes. There will be a round chorus of "boos" when it is realized that part of the subsidy may be diverted to handicap a legitimate industry.

The subsidy works like this: all synthetic rubber produced is owned by the Rubber Reserve Co., a government agency. The cost of making the rubber is somewhere around 20 cents above the old established price of crude rubber which the government set when it took over all crude rubber stocks at the beginning of the war. This rubber is disposed of differently to various manufacturers—there is one policy for material that is to be used for the Armed Forces and another for material to be used in civilian consumption. When the rubber manufacturers were forced to shift from crude to synthetic as in the Navy life rafts, they would not pay the old price of about 21 cents for crude plus the addition 18 to 20 cents (which represents the total cost to the government of producing a pound of synthetic rubber) without adjustment of their contracts. So the Armed Forces went to Rubber Reserve and said: "You sell this synthetic rubber to the manufacturer at 21 cents so we can buy our life rafts at the same price we paid for life rafts made from crude rubber. Then we (the Army or Navy) will reimburse the Rubber Reserve Co. with the extra 18 to 20 cents which is the difference between production cost of synthetic rubber and their selling price to the rubber manufacture." The life rafts still cost the Armed Forces and the taxpayer 39 cents a pound for all the rubber used in them, but the procurement officer shows on his books that he is only paying 21 cents or thereabouts. The 18 cents subsidy is handled in a separate transaction. If a vinyl manufacturer wants to compete, his price must compete with the 21 cent figure regardless of the fact that the Army and Navy is really paying 39 cents.

But another system is used if the synthetic rubber is sold by Rubber Reserve to a manufacturer who wants to make a civilian item such as rubber gloves. In that case, the synthetic rubber is sold directly to the processor for, say 21 cents. The government absorbs the 18-cent loss, for the government is paying 39 cents a pound to manufacture the stuff. In this case the taxpayer makes up the difference just the same as before, but the bookkeeping is different. The copolymer plants where the synthetic rubber is produced at a cost of approximately 39 cents are operated theoretically by the Rubber Reserve Co., under Jesse Jones, the R.F.C. Director. Management and actual production is supervised by experienced rubber executives from the leading companies.

Critics of the vinyl industry's opposition to the synthetic rubber subsidy policy often ask: "What do you care? There



No. 2 Royle Plastics Insulating Machine.

"ANY INSULATION" WON'T DO WHEN YOU'RE FIGHTING A GLOBAL WAR

The long felt need for insulating materials possessing properties not found in rubber skyrocketed as the war spread to all quarters of the globe. This was a need that had to be filled almost overnight. Delays meant the needless loss of precious lives—stymied campaigns—prolonging the war.

John Royle and Sons—progressive pioneers since 1880 in the manufacture of extrusion machinery—were called upon to produce the necessary equipment for processing plastics insulation.

To-day Royle Continuous Resin Insulating Machines are delivering plastics insulated wire in many of the nation's wire processing plants—"enough and on time."

More general applications of the Royle Continuous Resin Insulating Machine are manifesting themselves. The horizon is bright, but that must wait until the war is won.

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PIONEER BUILDERS OF EXTRUSION MACHINES SINCE 1880

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Akron, Ohio
J. C. Clinefelter
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James Day (Machinery) Ltd.

are plenty of applications for vinyl that synthetic rubber can't touch." True enough, but unfortunately the vinyl resin producers and fabricators have a much more difficult time than the synthetic rubber folks in obtaining the necessary chemical raw materials which are used for the same applications. This is because the synthetic rubber program is a sacred political cow, and there is seldom any doubt that chemical raw materials will be made available to run synthetic rubber plants to capacity even though the production may be used for some non-essential civilian use where less critical substitutes are available. The vinyl resin industry must justify the importance of each end use to obtain the necessary plasticizers, solvents and even the raw materials to make the vinyl resins. In this case, the vinyl resin people only ask that the Office of Rubber Director justify civilian end uses.

The vinyl people only want treatment on an equal basis. They assert that the basis of contract letting should be on a test performance. Furthermore, they point out that synthetic rubber reacts differently from crude rubber in nearly all applications. It needs observation, experimentation and testing just as surely as the vinyls did in their early stages of development. When the merits of the two materials are thoroughly tested and vinyl is rejected because of a failure, there will be no complaint. The chief criticism today is an artificial price structure and a pressure effort to force the use of a competing item.

Cellulose acetate and acetate butyrate allocation

An improved situation, with reference to supply and demand, was indicated in the November allocations. Requests for molding material are beginning to approach normal requirements, in comparison to the 450 percent above production capacity asked for in September. Additional information on over-all requirements, the "30 day" limitation on purchase orders, and increased availability of other materials, have helped to straighten out the situation and to make possible the allocation of material to usages, which in the past, have received consistent denials.

The November allocations covered many requested items in full, as opposed to the earlier policy of percentage approval. These items are not to be confused with such things as combs, cosmetics and religious items, for which the allotment was determined on the basis of base-period operations. In each of these cases, a pre-determined amount of material was earmarked for the specific end-use and was distributed in accordance with the applicant's past consumption. Beginning with the November allocations, WPB put into force its pre-announced policy of allocating thermoplastic molding powder to molding firms only. Applications from firms without molding equipment must show the molder to whom the powder is being delivered for processing.

Vulcanized fibre tubing in tight jam

Vulcanized fibre was exceedingly tight only a few months ago. But less than one month ago, more than 1,500,000 lb. was earmarked for ration tokens. Many persons thought that ration tokens were unessential. Dumped on top of this situation is the fact that vulcanized fibre tubing is threatening to become tighter than it ever was. There are several reasons for the present situation. First, the vulcanized fibre sheet situation has eased due to the cancellation of large requirements for export and military uses. That easement created a situation whereby fibre making equipment might become idle within a very short time. Then OPA stepped in with ration tokens. The large equipment requirements needed for manufacture of another type plastic ration token caused the OPA to review the possibility of using vulcanized fibre. It was found that by changing the thickness band from .100 to .050 in., where the maximum available capacity existed, sufficient fibre for ration tokens could be produced without delaying the production of military or essential civilian orders. Further, since the entire production of ration token fibre will be completed within less than 2 months, no serious delay on an unexpected military order would ensue.

Although sheet fibre has eased, the situation on fibre tubing has been critical to a point where strict control is mandatory. Vulcanized fibre tubing is particularly adaptable for use as electrical fuse tubes and is in great demand at this time by both military and civilian consumers. And the manpower situation has been so critical in vulcanized fibre tube mills that until recently, they had been running at only one-half capacity. While fibre sheet and fibre tubing are, in general, produced by the same company, the equipment is very different. The procedure also is different, making it impossible to take manpower from sheet fibre machines and put it on tube making machines. In most cases the tube making mill is in a different town than the sheet mill.

As the uses for vulcanized fibre tubing are on a very high essentiality level, it was considered unnecessary to allocate in the strict sense of the word. A lump allocation was made each month without scrutinizing each end use. Spot checks indicated that less than one hundredth of one percent of the output was going to uses that were unessential. This ratio of essential to unessential was confirmed last month when frenzied buying increased the load on the fibre mills to the extent where strict allocation has had to be enforced. It is believed that the present tight situation may continue for some time because there is no possible way to convert sheet facilities to tube facilities.

Ceiling price adjustment for calcium carbide

Ceiling prices for Defense Supplies Corp. sales of calcium carbide, major raw material in the manufacture of acetylene, were reduced on Nov. 1, by OPA to levels approximating prices charged by commercial sellers. This chemical is used in the manufacture of practically all the large field of vinyls, melamine, acetic acid, acetic anhydride, trichloroethylene and neoprene. Its distribution by DSC and commercial sellers is almost completely allocated.

DSC has been selling the output of our plants—that of the Tennessee Valley Authority at Sheffield, Ala., the Electro-Metallurgical Co., Ashtabula, Ohio, the marginal output of the Monsanto Chemical Co., Anniston, Ala., and a contracted amount of calcium carbide from Canada at a considerably higher price than the price charged by commercial sellers. Although the new ceilings for sales to chemical plants are somewhat higher than ceiling prices paid previously to private producers, they are close enough to commercial levels to prevent serious price dislocations according to OPA.

E. F. Swenson goes to work for General Marshall

E. F. Swenson who has been administrator of 4 orders in the Thermoplastics Unit of Plastics Section has given up his blue pencil to carry a rifle and throw grenades in another branch of Uncle Sam's service. His responsibilities in WPB will be taken over by C. D. Kerr, John Adrian and Mrs. Loretta Sloan, all of whom have been working on various phases of these different orders since early summer.

L. P. Hohlfelder takes on additional task

When Herbert C. Haag, administrator of the plastics machinery order L-159 left WPB to join the engineering staff of Celanese Corp. of America, his duties were taken over by Leonard P. Hohlfelder who is an assistant in the office of the Chief of the Plastics Unit. He will continue his work as administrator of the Synthetic Rubber Plant Requirement Unit which is now included in the office of the Chief. He is responsible for raw materials allocations required in the synthetic rubber program, namely, butadiene, styrene, acrylonitrile.

More women for war jobs

The War Manpower Commission has recommended an additional and immediate wide-scale development of adequate in-plant training program for women workers. Included in the recommendation is this statement: "To help maintain a satisfactory degree of morale and to keep women working at their highest efficiency and producing to their maximum capacity, carefully planned step-by-step training on the job should be given by well-chosen, skilled (*Please turn to page 170*)

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IN THE NEWS

★ COL. GILBERT I. ROSS, DISTRICT CHIEF OF THE New York Ordnance District, Army Service Forces, has announced creation of a Technical Advisory Committee composed of: Gregory Jamieson Comstock, professor of Powder Metallurgy, Stevens Institute of Technology; Dr. Ralph L. Evans, Ralph L. Evans Assoc.; Howard A. Poillon, president, Research Corp.; Dr. Augustus B. Kinzel, Union Carbide and Carbon Co.; and Thomas H. Wickenden, manager of Development and Research Div., International Nickel Co. The duties of the members of the committee are to act as consultants to Thomas J. Little, Chief of Conversion Engineering Section, and his associates on technical problems pertaining to mechanical engineering, plastics, powder metallurgy and related subjects.

F. H. BANBURY

D. A. COMES

★ AT HIS OWN REQUEST, FERNLEY H. BANBURY has retired from active management of the Banbury Mixer Dept., Farrel-Birmingham Co., Inc., Ansonia, Conn. In the future he will act in a consulting capacity, maintaining his headquarters at the company's main office. He will be succeeded by D. A. Comes who has been associated with Mr. Banbury in his work for the past 21 years. D. G. Warner has been appointed assistant manager of the department.

Mr. Banbury is internationally known for his invention of the Banbury Mixer. He has been connected with Farrel-Birmingham Co., for 27 years and has been manager of the Banbury Mixer Dept. for the past 15 years. For more than a quarter of a century he has devoted most of his time and attention to developing ways of increasing the mechanical and operating efficiency of the mixing machine which bears his name, and working out new applications.

★ OWENS-CORNING FIBERGLAS CORP., NEWARK, Ohio, has completed a new laboratory center which brings under one roof all the purely scientific divisions of the company's research organization. The center will operate under the direction of Games Slayter, vice-president in charge of research. A major field of the new testing laboratory will be a testing program aimed at development of the use of Fiberglas as reinforcement for plastics. The center is equipped with apparatus to determine the physical properties of pure plastics as well as those of Fiberglas-plastic combinations.

★ B. F. GOODRICH CO., AKRON, OHIO, THROUGH F. Lang, manager of the company's shoe products sales department, has announced the manufacture of a new vinyl-resin shoe soling material which is said to have "remarkable wear resistance yet is light enough to lead toward the super-light and super-flexible shoes of the future." While the soling material now is strictly a war material, extensive tests by Akron mail carriers and messenger girls in the company plants, indicate that these soles give several times the service of other materials. The soling can be made in any color.

The company has announced 2 new products for covering plating racks. These materials are known as Koroseal Tape RX and Koralac RX, a solution of Koroseal. In some applications the 2 are used together, with the tape applied after the rack has been coated with the solution. Koroseal Tape RX is said to possess good resistance to wear and abrasion, excellent insulating properties and remarkable resistance to all plating solutions. The solution Koralac RX provides a corrosion resistant, tough, inert coating with good insulating properties.

★ U. S. PLYWOOD CORP., HAS PURCHASED A BUILDing at 55–57 W. 44th St., New York, N. Y., which after alterations will accommodate the company's executive offices. The company has been authorized by the U. S. Army, Corps of Engineers, to announce that its Algoma, Wis., plant has launched the one-thousandth hull for the Army's utility power-boats. Said to represent the largest piece of compound curved plywood ever produced commercially, the hulls are 18 ft. long with a maximum width of 6 ft. 7 in., and a maximum depth of 3 ft. 2 inch. They comprise 7 plies of $^1/_{16}$-in. veneer molded in one piece with the 2 outer layers of impregnated birch.

By reason of the Army's cancellation of its huge plywood cargo plane program, surplus stocks of aircraft plywood now are available to various industries without priorities according to C. S. Creigh, sales manager of U. S. Plywood Corp. Mr. Creigh described these surpluses as over-runs and cutbacks on war orders.

★ ACCORDING TO AN ANNOUNCEMENT BY CHARLES Belknap, president of Monsanto Chemical Co., St. Louis, Mo., Francis J. Curtis has been elected vice-president of the company. Mr. Curtis will be in charge of the company's long-range program of development here and abroad. His work will include general research and general sales development.

★ WALTER J. A. CONNOR HAS BEEN APPOINTED vice-president and director of sales of Chemaco Corp., distributor for Manufacturers Chemical Corp., Berkeley Heights, N. J. His duties include complete distribution of Chemaco molding powder, both domestic, export and Government sales; and the sales of miscellaneous products and chemicals. Mr. Connor formerly was associated with Celanese Celluloid Corp., as its northeastern representative for the complete line of the company's plastic materials.

★ A. M. CREIGHTON, JR., FORMERLY PLASTIC & Rubber specialist for the New England Regional Office of WPB, now is associated with Berst-Forster-Dixfield Co., Plattsburgh, N. Y. His new work will pertain to the plastic industry.

★ JAMES WILSON HAS JOINED WATSON-STILLMAN Co., Roselle, N. J., and will be in charge of the company's laboratory for research and development of hydraulic equipment for the plastics industry.

★ ROHM & HAAS CO., NEW YORK, N. Y., HAS ANnounced that its molding powder, formerly known as Crystalite, henceforth will be called "Plexiglas molding powders." The change was made because the name Plexiglas has become so well known through its widespread use on aircraft for transparent streamlined bomber noses, etc. Since the molding powders are made from the same basic raw materials, the change makes for clarity and simplification.

★ ELMER E. MILLS CORP. HAS MOVED TO NEW quarters at 153 W. Huron St., Chicago, Ill. The change was made to enable the company better to serve its customers.

★ DR. IRVING HOCHSTADTER HAS BEEN MADE REsearch administrator to Gallowhur & Co., manufacturers of the newly developed puratized process for treating plastics, textiles,

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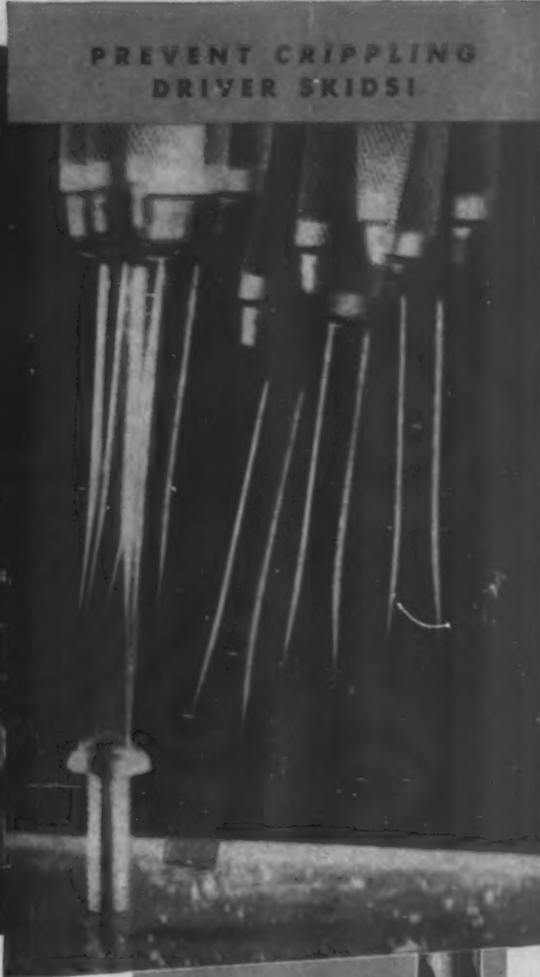
Photo by Office of War Information



PHILLIPS SCREWS ARE SKID-PROOF!

No hand-injuries from skidding screw drivers! That's the protection against absenteeism you can get by using Phillips Recessed Head Screws. The scientifically designed Phillips Recess automatically centers the driver in the screw head . . . utilizes full turning power . . . and "brakes" the driver against skidding!

Safe, faultless screw driving no longer means slow output. Old hands and new, alike, work faster and surer with Phillips Screws. There are no fumbling, wobbly starts . . . slant-driven screws . . . or burred and broken screw heads. Spiral and power driving are made practical. In literally thousands of plants, replacement of slotted-head screws by Phillips Screws has increased screw driving speed up to 50% . . . and has entirely eliminated rejections due to driver gouges.

Compare the costs of driving Phillips and slotted head screws. You'll find that it actually costs less to make fastenings with Phillips Recessed Head Screws!

KEY TO FASTENING SPEED AND SAFETY

The Phillips Recessed Head was scientifically engineered to afford:

Fast Starting – Driver point automatically centers in the recess . . . fits snugly. Screw and driver "become one unit." Fumbling, wobbly starts are eliminated.

Faster Driving – Spiral and power driving are made practical. Driver won't slip out of recess to injure workers or spoil material. (Average time saving is 50%.)

Easier Driving – Turning power is fully utilized by automatic centering of driver in screw head. Workers maintain speed without tiring.

Better Fastenings – Screws are set-up uniformly tight, without burring or breaking heads. A stronger, neater job results.

PHILLIPS *Recessed Head* SCREWS

WOOD SCREWS · MACHINE SCREWS · SELF-TAPPING SCREWS · STOVE BOLTS

21 SOURCES

American Screw Co., Providence, R. I.
The Bristol Co., Waterbury, Conn.
Central Screw Co., Chicago, Ill.
Chandler Products Corp., Cleveland, Ohio
Continental Screw Co., New Bedford, Mass.
The Corbin Screw Corp., New Britain, Conn.
The H. M. Harper Co., Chicago, Ill.
International Screw Co., Detroit, Mich.
The Lamson & Sessions Co., Cleveland, Ohio
The National Screw & Mfg. Co., Cleveland, Ohio
New England Screw Co., Keene, N. H.
The Charles Parker Co., Meriden, Conn.
Parker-Kalon Corp., New York, N. Y.
Pawtucket Screw Co., Pawtucket, R. I.
Pheoll Manufacturing Co., Chicago, Ill.
Reading Screw Co., Norristown, Pa.
Russell Burdsall & Ward Bolt & Nut Co., Port Chester, N. Y.
Scovill Manufacturing Co., Waterville, Conn.
Shakeproof Inc., Chicago, Ill.
The Southington Hardware Mfg. Co., Southington, Conn.
Whitney Screw Corp., Nashua, N. H.

paper, etc., to inhibit the growth of mildew-forming micro-organisms; and other strategic chemicals. Formerly Dr. Hochstadter was president and technical director of Hochstadter Laboratories, Inc., and of Still and Van Siclen, Inc.

★ SANDEE MANUFACTURING CO., CHICAGO, ILL., has appointed Electrical Specialty Co., as its Pacific coast representative. This West coast company has offices at 316 Eleventh St., San Francisco; 418 E. Third St., Los Angeles; and 2406 First Ave., Seattle. It will represent Sandee on its entire line of flexible plastic tubing, extruded thermoplastic stock and custom section.

★ ELLIOTT A. ALLEN, 1913 N. VERMONT AVE., LOS Angeles 27, Calif., has announced the opening of an Engineering Service for those interested in the design and development of articles made of plastics; the design of molds, dies and forms; recommendations of proper plastics materials and production processes. Mr. Allen will serve as a consultant on forming and fabricating laminated phenolic sheets, transparent acrylate sheets and transparent acetate sheets for aircraft parts, furniture, household fixtures and novelties.

J. M. DEBELL

H. M. RICHARDSON

★ AS OF DECEMBER 1, JOHN M. DEBELL AND HENRY M. Richardson are opening offices in Longmeadow and Pittsfield, Mass., for the purpose of helping plastics industrialists to discover how they can further apply plastics toward winning the war, how they can conserve man-hours and how they best can prepare for plastics utilization after the war. They will operate under the name of DeBell and Richardson.

Since 1939, Mr. DeBell has been in the consulting field. This period includes service in 1942 as a "dollar-a-year" consultant for WPB. He is an adviser to the Research and Development Branch, Military Planning Div., Office of Quatermaster General. Mr. DeBell initiated the chemical phases of General Electric Co.'s phenolic compound production and, in 1929, he suggested the formation of the present General Electric Plastics Department. In 1935, with D. R. Wiggam, he built and operated the first commercial ethyl cellulose plant in this country for Hercules Powder Co. His group leaders at Fiberloid Corp., put that company and its subsidiaries into the manufacture of vinyl acetal resins, vinyl safety glass plastic by new forming methods, transparent continuous cellulose acetate sheet, cellulose acetate molding powders and nitrocellulose emulsions, paving the way for merger with Monsanto Chemical Co.

For the past 7 years Mr. Richardson was chief engineer, Plastic Div., General Electric Co. His duties included supervision of development, engineering and quality control in the 5 molding and laminating plants of the company. From 1928 to 1936 he was in charge of the development of new uses for plastic products for General Electric Co., holding the title of Application engineer, Plastics Div., with headquarters at Lynn, Mass.

★ PLASTICS INSTITUTE ALUMNI ASSOC., AT ITS meeting on November 18 at the Hotel Pennsylvania, New York, N. Y., was addressed by Earl Simonds on "Postwar Potentialities of Plastics."

★ ORGANIZATIONAL CHANGES IN THE SALES DEPT., Plastics Dept., E. I. du Pont de Nemours & Co., Inc., have been announced by W. A. Joslyn, director of sales. W. F. Jensen has been appointed special assistant to the director of sales; L. B. Gillie, assistant director of sales; E. H. Tyson, sales director of molding powders; and M. M. Taylor, sales manager of sheets, rods and tubes.

Workers and management of Plastics Dept., of the company at Arlington, N. J., were presented with the Army-Navy "E" production award in recognition of splendid achievements performed in the production of Lucite sheeting for aircraft.

★ HERCULES POWDER CO., WILMINGTON, DEL., HAS announced the election of Paul J. Weber, economist and head of economic research department of the company, as assistant treasurer. Mr. Weber who joined the company in 1934, will continue the direction of economic research in addition to his new duties.

★ CONTINENTAL CAN CO., INC., SWEDLOW AERO-plastic Corp., and Marco Chemicals, Inc., have agreed to pool their combined knowledge and production facilities to make available for Army and Navy planes, parts made from the new MR-type synthetic resins which are manufactured by Marco Chemicals, Inc. At present efforts will be concentrated on the production of laminated fiber-resin compositions made of paper, cotton cloth, glass cloth, asbestos and wood veneer. To assist in this collaboration, Cecil Armstrong has been appointed chief engineer of Marco Chemicals, Inc.

★ ACQUISITION OF JOSEPH STOKES RUBBER CO., BY Thermoid Co. has been announced by F. Schluter, president of the latter company. The principal motive for the acquisition was said to be the desire of the Thermoid Co., to augment its Industrial Rubber Sales Div., with manufacturing capacity and technique on hard rubber products and plastics; and to bring to the company a Canadian manufacturing subsidiary.

★ WARTIME RESEARCH DEVELOPMENTS IN LAMINated plastics, and postwar applications to fill industrial and consumer needs was the theme of a 3-day seminar held by Formica Insulation Co., Cincinnati, Ohio, on October 28 to 30.

★ WORD HAS BEEN RECEIVED OF THE DEATH OF Edgar V. O'Daniel, vice-president and director of American Cyanamid Co., and president of the company's Canadian subsidiary, North American Cyanamid, Ltd. At the time of his death, Mr. O'Daniel was chairman of Committee on Economic Policy and director of Chamber of Commerce, U.S.A., trustee of National Industrial Conference Board, director of Commerce and Industry Assoc. of New York, and member of the board of Lawrence Hospital. Before assuming the vice-presidency of American Cyanamid Co., in 1923, Mr. O'Daniel was treasurer of Air Nitrates Corp., and also the vice-president of National Carbide Corp.

★ JOHN B. SCHEER HAS BEEN MOVED FROM THE general Tenite sales office of Tennessee Eastman Corp., Kingsport, Tenn., and now is sales representative for Tenite in Buffalo. He replaces Eugene C. Cathcart.

★ CASEIN CO. OF AMERICA, NEW YORK, N. Y., IS distributing upon request a new issue of its chart, "Glue Recommendations for U. S. Government Specifications." The new chart is said to illustrate two trends. The number of new specifications shows the growing acceptance of glued wood as a war production item, and 3 new specifications (No. 8, 43 and 44), denote official recognition of a new type of glue—non-acid, low-temperature phenol-resin.

★ GRAND RAPIDS INDUSTRIES, INC., MONUMENT Square Bldg., Grand Rapids 2, Mich., is sponsoring a competitive showing in January under the banner of "Exhibit of Furniture Ideas for Postwar Homes." The company is inviting industries

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engaged in plastics, fabrics, glass, rubber, steel, etc., to tell their own stories to the home furnishing industries by participation in this exhibit. Entry certificates may be obtained from Howard R. Sluyter, at the above address.

★ JAMES S. WILSON HAS BEEN APPOINTED ENGINEER in charge of Plastics, Research and Development Div., Watson-Stillman Co., Roselle, N. J. Mr. Wilson formerly was with Niagara Insulbake Co.

★ KARL M. JOEHNCK HAS BEEN APPOINTED VICE-president and production manager of Manufacturers Chemical Corp., Berkeley Heights, N. J. Formerly Mr. Joehnck was buyer for Receiver Div., Electronics Dept., General Electric. Co.

★ DOUGLAS T. STERLING CO., NEW YORK CITY, HAS announced its partnership with Donald R. Dohner and J. Gordon Lippincott in the work of market analysis, industrial design and merchandising.

★ POSTWAR AUTOMOBILES MAY TAKE ON A NEW brilliance thanks to lacquer made out of potatoes. The new product which has yet to make its large-scale debut, is starch acetate, a chemical relative of cellulose acetate made from cotton and wood pulp. The starch acetate, described before the American Chemical Society meeting by 2 U. S. Department of Agriculture research workers, can be made by either of 2 processes. In one, the potato starch is treated directly with acetic acid in the presence of a stronger acid such as sulfuric. In the other, the starch grains are put through a pre-swelling stage in formic acid, and the acetic acid then added. The second process is much quicker requiring only an hour's cooking just short of the boiling point compared with 9 hours when unmodified starch is used.

★ FOR CONTINUED EXCELLENCE OF PERFORMANCE and production, Franklin Plastics Div., Robinson Industries, Inc., Franklin, Pa., was awarded a renewal of Army-Navy "E."

Sorry!

★ IT HAS BEEN CALLED TO OUR ATTENTION THAT in the article on ethyl cellulose that appeared on pages 101–103 and 163 in our November issue, photographs No. 5 and 9 were transposed.

★ WE REGRET THAT IN THE STORY ON "INJECTION molding of nylon" which appeared in our November issue, we failed to mention that the photograph of the slide fastener which appeared on page 115 was furnished by Crown Fastener Corp.

★ IN THE ARTICLE, "THE FUTURE OF THE INJECTION industry," which appeared on pages 90, 140–42, of our August issue, patent No. 1,533,617 should have been listed in the names of Soss and Morin.

★ IN THE ARTICLE "AUTOMOTIVE TECHNIQUES IN war," which appeared on pages 72–4, 150–1 in the October issue of the magazine, we failed to mention that Lamicoid is the material used in the repeater dial for a gyro-compass.

★ WE REGRET THAT IN OUR MENTION OF J. L. Rodgers, Jr., in the SPI news which appeared on page 134 in the October issue, we incorrectly associated him with Owens-Illinois Glass Co. Mr. Rodgers is president of Plaskon Division, Libbey-Owens-Ford Glass Co., Toledo, Ohio.

★ IT HAS BEEN CALLED TO OUR ATTENTION THAT the Venturi tubes described in Item 3, page 84 of our October issue, are molded of Lumarith E. C. The same material, Lumarith E. C., is used in the molding of the propeller protractor parts discussed on page 79 of the same issue.

★ OUR EXPLANATION OF THE GERMAN TRADE-mark which was reproduced on page 150 of the October issue was in error. KFB means the firm of Krieger & Fraudt Berlin. The number 78 is this firm's number at the Material Prufungsamt in Dahlen-Berlin where every firm, which permits their items to be tested, has a number. The letter S stands for material used in the item, in this case, phenol resin with wood-flour filler. *(Please turn to page 170)*

Speeches of the month

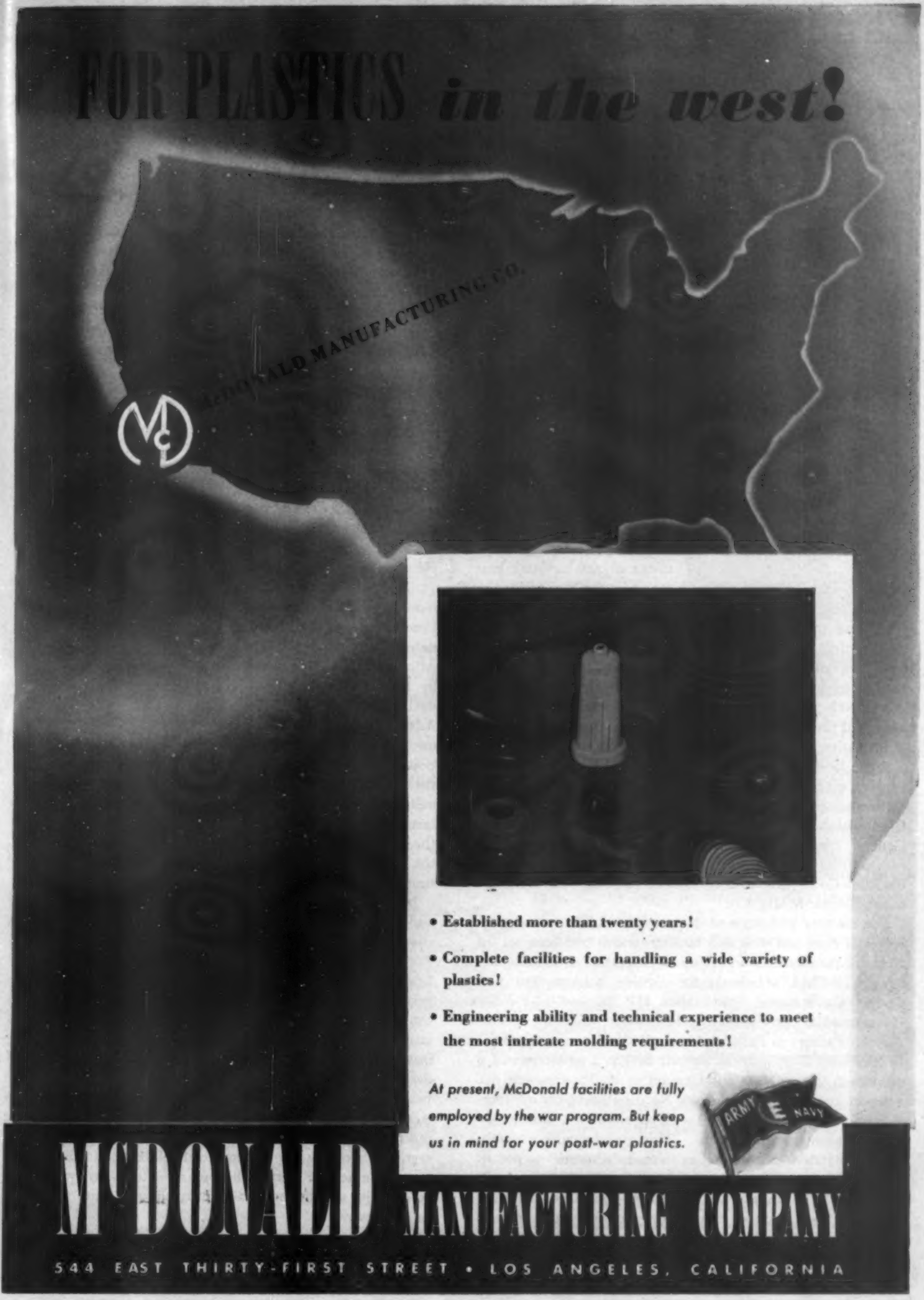
★ NEW CHEMICAL TREATMENTS THAT ARE CREDited with virtually endowing wood with the properties of a plastic and giving it added strength, wearing qualities, hardness, and warp and swell were described by Dr. J. F. T. Berliner of Ammonia Dept., E. I. du Pont de Nemours & Co., Inc., at a meeting on Oct. 22 of the Eastern Lumber Salesmen's Association in Philadelphia, Pa. Dr. Berliner said that the treatment of these new chemical methods develops such unusual properties that "actually we no longer are dealing with wood." He said that it has been found that when wood is impregnated with a resin solution such as a lacquer, the resin may fill the wood cells but the properties of the wood are not altered fundamentally. However, if the wood is impregnated with resin-forming chemicals capable of reacting with the wood cellulose, and the resin then produced within the wood, the properties of the wood are altered profoundly. The speaker noted the postwar possibilities of dimensionally stable lumber eliminating sticking drawers, doors and windows.

★ "THE ROLE OF MINERALS IN OUR FUTURE ECONomy" was the subject of the address of Games Slayter, vice-president and director of research of Owens-Corning Fiberglas Corp., at the annual dinner of Industrial Minerals Div., American Institute of Mining and Metallurgical Engineers held on October 22. Mr. Slayter described a new material, a plastic reinforced with glass fibers, now being employed in aircraft construction. Experimental samples have been produced with tensile strengths of over 80,000 p.s.i. The material can be molded into aircraft structural parts with low pressures and without use of expensive molds, Mr. Slayter said. In explaining the principle involved in the manufacture of glass and plastic combinations, he explained that all materials contain imperfections. If the material is uniform in its structure, stresses accumulate around the imperfections. Nature guards against failure of her strong materials by fiberizing them. When we draw glass into fine fibers and combine them with a plastic we distribute the imperfections so that there is not one chance in a million that those in one fiber will match with those in another.

★ GEORGE FOWLES, B. F. GOODRICH CO., IN A speech before the 13th annual convention of the Wire Association held in Chicago on Oct. 21, expressed the belief that those wire-insulating materials whose flame resistance is a vital asset to Allied warships and tanks, eventually will help reduce the number of home fires which develop as a result of electric wiring faults. The exceptional "self-extinguishing" characteristics of some of the modern vinyl chloride thermoplastics, Mr. Fowles said, have been the chief factors in the adoption of the materials for wire and cable insulation by the Navy.

★ DR. KENNETH E. MARTIN OF ROHM & HAAS CO., told members of New York Institute of Finance on October 25 that postwar vehicles will be distinguished by synthetic plastics, particularly the super-transparent type now used in our warplanes. He pointed out that the future of our synthetic plastics industry can be gaged by noting the strides made by these light, strong and colorful materials prior to World War II. He mentioned many of the uses to which plastic materials are being put in war equipment.

★ SPEAKING AT THE ANNUAL CONCLAVE OF OFFIcers and managers of the Westinghouse Electric & Mfg. Co., A. W. Robertson, company chairman, said that the company's postwar planning was being done with an eye to keeping expanded production capacity occupied after the war. He stated that Westinghouse will be able to resume production of electric appliances for the home within a few weeks after the war is over. Mr. Robertson cautioned that the company anticipates no revolutionary changes in design of its equipment during the first few years of peace.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Laminating industry test program

UNTIL the outbreak of the war, the manufacturers of laminated plastics were under the impression that they knew the properties of their material from beginning to end. Then came the scarcity of aluminum. A demand arose for laminated materials to be used in aircraft as a replacement for this critical metal, and the industry found that it had very little data about those properties of laminates which are of prime importance in structural applications. To obtain concrete facts about their materials as applied to the aircraft field, the manufacturers organized and financed a test program at Johns Hopkins School of Engineering, Baltimore, Md. From this program, which even now is preparing for actual production testing after a training period, the industry hopes to develop data for specifications for laminates which will be applicable not only to the aircraft industry but to any industry that develops interest in the materials.

G. H. CLARK

While the war created the pressing need for a testing program and overrode considerations of competition that at another time might have prevented individual manufacturers from cooperating on such a project, the organization of the laminating industry did much to simplify the task. For a good many years the manufacturers of laminated plastics have sold the bulk of their products to the electrical industry as insulating materials. Because of this concentration within a single field, the 11 suppliers of these plastics became organized within the National Electrical Manufacturers Association as a Section. The membership of this group includes: Continental-Diamond Fibre Co., Formica Insulation Co., General Electric Co., Mica Insulator Co., National Vulcanized Fibre Co., Panelyte Corp., Richardson Co., Spaulding Fibre Co., Synthane Corp., Taylor Fibre Co., and Westinghouse Electric & Mfg. Co.

For the type and scope of its prewar products the industry was well equipped with test facilities which had been set up to check the electrical and physical properties of its materials against NEMA standards for civilian consumption and against Government Specification HP-256 and 17-P-5 for Governmental procurement. However, when the Naval Aircraft Factory in Philadelphia applied to the manufacturers of laminates to go into the aircraft field as a replacement for aluminum, the A.N.C. Sub-Committee on Plastics sent out a report known as Questionnaire No. 1 outlining the information on grades of plastics that were required for a satisfactory job of aluminum replacement. This questionnaire was submitted to individuals as well as to manufacturers—to practically every man who could claim in any way to be a plastic producer. The minute the laminators examined the questionnaire they realized that no one company or group of companies in the industry was equipped or qualified to produce the information required.

As an alternative to the information requested on Questionnaire No. 1, the Plastics Industry Committee on Laminates, a cooperative committee composed of members from S.P.I. and from the Laminated Section of NEMA, took the responsibility of submitting representative samples of their products to the Naval Aircraft Factory. The N.A.F., acting as a test agency for the A.N.C. Sub-Committee on Plastics, accepted these standard products as well as many new combinations suggested either by the manufacturers or by the Sub-Committee. As a result of tests which originated at the N.A.F. and at Wright Field, there was created a sustained interest in laminated plastics for aircraft. Impetus was given to this trend when individual manufacturers collaborated with aircraft manufacturers on the development of new products and new material combinations, some of which reached production quantities.

George H. Clark, Vice-President and Chief Engineer of the Formica Insulation Co., a member of the Plastics Industry Committee on Laminates and the Laminated Section of NEMA, was given the responsibility of keeping the Laminated Section of NEMA informed of all developments. On October 24, 1942, Mr. Clark made a report to the Technical Committee of the Laminated Section of NEMA. After a study of this report by both the A.N.C. Committee and NEMA, the A.N.C. Committee submitted to the Industry Questionnaire No .2. Although the information requested on this latest questionnaire was far more concrete and specific, the laminating industry still was faced with an insolvable problem. While it was agreed that the information was important from a strucutural standpoint, the laminators were without the equipment necessary for running the tests which would give the required data.

DR. R. K. WITT

In the meantime the lighter metals had become less critical and the program of applying laminated plastics to aircraft changed from one of substitution to one of direct competition. Today applications of laminated plastics to aircraft are based on merit and must be economically sound. However, because of interest created in the aircraft industry, there is a continuing demand for laminated plastics. This sustained interest in laminates as structural material, together with realization of the lack of testing facilities, moved the Laminated Section of NEMA to start an investigation to determine the best method of getting the information requested by the A.N.C. Sub-Committee on Plastics. Three possibilities were discussed: 1) to make use of the services of a commercial testing laboratory; 2) to concentrate all its test facilities with one manufacturer, setting him up as a test agency; and 3) to organize and finance a test program at a suitable college or university.

After due consideration it was decided to investigate the possibilities of the latter proposal. This task was given to George H. Clark who spent ap- (*Please turn to page 166*)


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Electron microscope

(*Continued from page 125*) the replica side up. The silica squares will be released from the styrene in some 5 min. and can be easily seen in the liquid. The silica films are removed from the first solvent and placed in a dish of fresh solvent to remove any additional styrene. From here they are picked up on the specimen screen, ready for the microscope.

It is important, of course, that all details of the original sample be reproduced accurately throughout the process. Were it not for the detail with which polystyrene can be molded, this would not be possible. Actually this 2-step process utilizing polystyrene offers important advantages in the electron microscope:

1. High resolution and excellent contrast. A resolution of 40 Å is readily obtained in the silica reproduction.

2. The method is independent of the surface properties (surface tension, hydrophilic films, etc.) of the material to be studied and depends, rather, upon externally applied pressure to produce the first replica. Hence, it finds application to a wide range of surfaces such as nearly all metals, glasses, etc. It is well adapted to metallographic studies.

Polystyrene has been found to be best suited to the process due to its chemical inactivity, dimensional stability and moldability. The low water absorption of molded styrene makes the first replica capable of being preserved for a considerable time before the final film of silica is prepared. Again, plastic materials are finding use in new and broader fields, serving mankind to gain knowledge of the mysteries of nature.

Fluorescent dyes

(*Continued from page 128*) with Calco fluorescent yellow AB, also given in Table II. These samples were then compared for intensity of fluorescence by means of a photometer which gave in arbitrary units a "fluorescence value" for each sample. Therefore, while these units do not bear any known relationship to lumens or candle power, they do form a numerical basis for comparing the fluorescent intensity of one sample with that of another.

The "fluorescence values" were determined on the electronic photometer using photocell C and a mercury arc as an ultraviolet source. A nickel oxide filter between the mercury arc and the sample allowed only ultraviolet light to reach the sample. A yellow gelatin filter (4716-7-A) between the photocell and sample insured against ultraviolet light reaching the photocell. Thus, the photocell registered only visible fluorescent light from the sample. A second filter over the photocell corrected the response of the photocell to correspond to that of the human eye. Photocell, irradiating source and sample were maintained in a constant and fixed position. The results of these tests are shown in Table IV.

Table IV.—Visible Fluorescence (Arbitrary Scale)

Background color	*Base color not coated*	*Base color coated with Calco rhodamine B stearate transparent enamel*	*Base color coated with Calco fluorescent yellow AB transparent enamel*
White	1.0	100.0	4630
Yellow	1.0	87.0	1860
Orange	0.0	32.5	115
Red, lake	0.5	49.5	406
Red, toner	0.5	52.0	349
Blue	7.0	55.0	1020
Green	3.5	30.0	1550
Gray	2.0	45.0	741
Brown	0.0	44.5	574
Black	0.0	40.0	397

Table IV illustrates clearly the loss in fluorescent intensity caused by application of a transparent fluorescent coating to a colored base. The percent loss depends on many factors: first, the fluorescence or reflectance of the pigment of the base; second, the color of the base; third, the color and transparency of the coating; and fourth, the color of the combination of the coating over the base. It is obvious from the above data that each case must be studied specifically for exact information, but in general, it may be stated that the greater the contrast between the base color and the fluorescent top coating, the greater will be the loss in fluorescent intensity.

Shipyard invasion

(*Continued from page 83*) ship no less than 60 pulleys varying in diameter from $2^1/_2$ to $3^1/_2$ in. are needed for this purpose, with considerable quantities of flat chain and stiff wire stretching from bridge to engine room. When brass was put on the critical list and it became increasingly difficult to obtain sufficient quantities of brass pulleys to outfit newly built ships, shipyards looked for a replacement. The changeover to laminated phenolic pulleys resulted in considerable saving of critical metal and a two-thirds reduction in weight, the average density of the material being .05 lb. per cubic inch. This saving in weight, together with the substitution of standard ball bearing, sleeve or graphitized bearing pulleys, has made it possible to discard flat chain and stiff wire and to substitute flexible cable for the entire system, increasing smoothness of operation. Other characteristics of the laminated phenolic material that make it ideal for this specialized application are its tendency to reduce noise and to resist corrosion, moisture and wear, factors considered in Naval tests that followed initial installation of the pulleys.

Circuit breakers—One of the newest applications of phenolic laminate to ship operation is as a medium for breaking the electric conductivity of brass ship rails which generally interfere with the reception of radio beam signals. Collars of laminated phenolic material inserted in brass railings serve as electric insulators and insure clear radio reception.

Engine covers—Diesel engines, powering submarine net tenders, mine sweepers, tugboats and other marine craft, are massive examples of modern advancement in power engineering. Frequently these marine engines are mounted on blocks of strong, lightweight, laminated, phenolic material in order to reduce vibration. Plastic parts for the engines have recently been developed and now are being used successfully to replace critical metals. Three such plastic applications appear in Fig. 8: a resin-bonded plywood-hardboard crankcase side cover; a laminated phenol-formaldehyde instrument panel board; and injection molded cellulose acetate butyrate identification and instruction plates.

Perhaps the most important and certainly the most inventive of these parts is the side cover of plywood-hardboard (Fig. 9). These covers, which give access to the crankcase for inspection and repairs, were originally made of aluminum. When aluminum no longer was readily available for this use, the engine manufacturer changed to cast iron. Shortly


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thereafter a plywood-hardboard cover was developed and quickly adopted.

By the lamination of lignocellulose hardboards to each side of plastic-bonded plywood, a rigid sheet is formed which approximates a true plane and thereby is capable of forming an oil seal when fastened in place over the crankcase apertures and of maintaining that seal during operation of the engine. The covers are oil- and heat-resistant, an important characteristic since the temperature of these Diesel engines reaches 180° F. during normal operating conditions. In developing this material for use as a closure plate, one of the difficulties experienced was the crushing action of the cap screws on the sheet when mechanics fasten the cover to the engine. Heavier washers were tried and discarded; hardwood plywood was considered and dismissed as being too scarce and too costly. Finally the problem was solved with a simple mechanical improvement. In each of the fastening holes in the cover there is inserted a metal bushing with an inside diameter slightly larger than that of the cap screw employed as fastener (Fig. 10). The bushing has a length $^1/_{32}$ in. less than the total thickness of the cover, allowing the sheet to be compressed for a tight fit but limiting the crushing action of the cap screw below the point of destruction of the material. The spacing of these holes is the same as previously was used for the metal covers. Although the cap screws are no closer together, a certain amount of oil leakage which was expected from the metal covers is not apparent with plywood-hardwood.

The weight of the new covers is $^1/_5$ that of the cast-iron plates. For example, the cover shown in Fig. 8 weighs 8 lb. as against 40 lb. for the former cast-iron cover. The durability of the plywood-hardwood plates has been proved by exhaustive shop tests in which the lightweight covers were given the equivalent of over 20 years' field wear. Engineering department heads of several large Diesel engine companies have reported no discernible deterioration after these tests.

Engine instrument panel—The plastic instrument panel board (Fig. 15) marks another innovation in the field of marine engines. It is constructed of laminated phenol-formaldehyde sheets. For added strength and to achieve the necessary curves, sides and top are backed with 5 layers of birch veneer laminated with a urea-formaldehyde glue, and with rims of heavy plywood. The base of the instrument panel, used for bracketing to the engine, is made of the same plywood-hardboard used in construction of the crankcase side covers. Mounted over the front end of the Diesel adjacent to the controls, the panel forms an attractive compact unit.

Engine nameplates—Liberal use is made of plastic nameplates on these Diesels (Fig. 8). Unlike the other plastic parts mentioned, these are injection molded rather than laminated. The nameplate mounted directly above the crankcase covers is molded from cellulose acetate butyrate as is the instruction plate shown at the extreme right side. In both cases the thermoplastic material was employed to replace aluminum previously used for the purpose. The instruction plate is a white molding with the lettering in relief. After the entire face is sprayed with black paint, the paint is sanded from the top of the raised lettering, permitting the white material to show through. Raised blank spaces are provided wherein engineering data can be stamped with ordinary steel punches. The chief operation in the production of the plates is the die making which is largely an engraving job.

Molded tools for building ships

Portable air mover—Specialized production equipment for shipbuilding is another field in which plastics have made important contributions. One of the newest applications is a portable air mover used in ship bottoms and other confined areas either to introduce fresh air or to suck up smoke, fumes and gases produced by welding and other construction operations. The new air mover is simple in design, consisting of a horn mounted on a two-piece, canvas-filled phenolic housing. The shipbuilders required a light, compact, durable piece of equipment and this unit meets every demand. The use of plastics in place of aluminum has effected a $^1/_3$ saving in weight. The small model has an overall length of only 31$^1/_4$ in., base diameter of 7$^1/_2$ in. and weighs just 5 lb. Even the large unit is only 47$^5/_8$ in. long with a base diameter of 14$^1/_2$ in. and a total weight of 37 lb. The air mover has no motor, fan, turbine or other mechanical parts and is simple, dependable and economical both in production and operation. Compressed air is fed through a metal insert groove in the plastic housing, then expanded at high velocity through the annular orifice, a small opening between the base and flange (Fig. 11). This produces a powerful venturi effect, drawing air or gases from the atmosphere through the bell-shaped opening in the plastic housing and forcing them up through the outlet horn.

The capacity of the unit to move a large volume of air has been demonstrated by actual test. One model, using 50-lb. compressed air at a rate of only 41 cu. ft. per min., was reported to have moved a total air volume of 561 cu. ft. per min., a 14-fold increase in air volume delivered. This performance was achieved with a portable compressor.

Canvas-filled phenolic was selected for this application because of the low weight and high impact qualities of the material. A 1-cavity mold is used for both the base and the flange (Fig. 12). Each of the parts is molded with 10 holes so that the two sections may be bolted together firmly. It is essential to the proper functioning of the unit that the two parts be molded with precision so that the annular orifice will have the proper dimensions.

Training and testing devices

Rounding out their varied service to the shipbuilder, plastics enter the training school, the research laboratory and the construction foreman's office. In all three, detailed plastic ship models meet pressing needs (Fig. 13). Of the hundreds of thousands of workers shifted from peacetime occupations to the building of ships, relatively few had previous experience in this industry. To speed their training in the highly specialized work of building Liberty ships, tankers and other types of marine craft, scale models are fabricated of hard vulcanized fibre covered with a sheeting of cellulose acetate to represent steel plating.

Working on a scale of half an inch to a foot, models have been made of many of the erectional sections that comprise a tanker. For such parts as deck house, forepeak, bulkhead, keel and inner bottom sections, deck section and bottom framing, models duplicate in minute detail a three-dimensional view of each and its relation to other fabricated parts.

The sheets of cellulose acetate in thicknesses of 0.0003 in. offer three advantages when applied to represent steel plating in scale models. The material's transparency makes possible easy observation of the inner construction of the erectional sections (Fig. 14). Because of the ease with which cellulose acetate can be shaped, such complicated shapes as the bulbous nose of a tanker can be constructed with a minimum of labor. Further, the sheeting is easily applied by scriving and attaching with acetate cement. Because of the constant use for training and other purposes to which these ship models are subjected, the strength of cellulose acetate sheeting is of great importance.

Shipyard engineers frequently use the plastic models to

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study new ways of fabricating erection sections. In a number of instances this has resulted in substantial savings of production cost and production time. One of the many practical uses is in facilitating assembly of fabricated sections of a ship. Crane operators usually make a preliminary study of the scale model before actually placing the fabricated unit in the hull, thereby obtaining information as to its construction and relation to other fabricated sections, and as to the quickest and most efficient method of handling the job. Another innovation is the use of varicolored sheets of cellulose acetate to represent bulkheads and other steel plate.

In this article just a few of the many plastic applications have been discussed, yet they affect every phase of the shipbuilding program. Neither shipbuilding nor plastics are static fields. Shipyards today are turning to the more complex Victory ship which undoubtedly will entail new production problems. The plastics industry is prepared to turn its resources to the solution of these new difficulties.

Credits:

Ship models: Material, Lumarith

Air mover: Material, Bakelite. Molded by American Molding Co., for Lamb Air Foil Co., and Mine Safety Appliance Co.

Pulleys on telegraph system and stern tube bearing: Material, Micarta

Stud welder: Material for housing, Bakelite. Molded by Remler Co., Ltd., for Nelson Specialty Welding Equipment

Wool-glass: Fiberglas

Diesel side covers and instrument boards: Material, Parallite and Panelyte. Manufactured by F. L. Mitchell Co.

Diesel nameplates: Material, Tenite II. Molded by Remler Co., Ltd.

Plumbing fixture

(*Continued from page 79*) is taken care of by an air valve and the extruded refill tube pictured in the completely assembled part (Fig. 2). The air valve consists of a small rubber ballcock washer which rides the top of the inlet pipe to permit water to flow into the tank when the ball float is lowered. It is held in place by the plastic cap which squeezes it closed as soon as the float ball reaches its filled position. The refill tube is attached directly to the top of this cap and will carry water into the toilet bowl to refill the toilet bowl to the proper level after flushing. These details are brought in at this point to indicate the close tolerances necessary to the successful performance of the device and the engineering thought which should go into all plastics industrial parts before molds are made.

The valve movement is exceedingly small. When the toilet is flushed, the float ball drops only enough to lift the cap about $^1/_{16}$ inch. This opens the valve sufficiently to permit plenty of water to flow into the tank to fill it promptly with a minimum of motion and moving parts. The float ball drops only about 2 in. during this operation and remains suspended until the water level reaches it again.

A plastic float ball rod may or may not be used. When the device is installed, this rod must be bent by the plumber to adjust the position of the float ball in order to regulate the water level in the tank. Since plumbers have used copper rods so long, bending them by hand without heating, there is some question whether or not they will respect instructions. The plastic rod must be heated through, then bent to the desired position and cooled with water before it will retain its new shape. And there is another problem with regard to the installation. Tightening plastics nuts with a Stillson wrench is damaging and unnecessary. Plumbers will have to be taught that plastics nuts can be set water-tight by hand. A wrench can be used, of course, if used gently for the final setting turn, but excessive pressure may damage both threads and nuts. The reason plastics nuts can be set water-tight by hand is that the material has resilience that is easily influenced by gentle pressure and very close contacts can be obtained. Also, plastics threads are sharper and more clearly defined than those cut in metal, and they do not have the ragged edges of most metal threads. If the plastic rod doesn't work out in practice, a copper or steel rod can be used instead. Threads are standard, and either copper or plastics will fit. However, the plastic rod has a number of advantages, and plumbers may take to it.

Economies inherent in the manufacture of these plastic ballcocks are obvious. So are shipping economies with weight reduced about 90 percent. Costs to the consumer should be about half that of the brass units. Two complete units come from the injection machine every 35 seconds, giving an approximate monthly capacity of 80,000 units from a single mold operated in two 8-hr. shifts a day. Since no sanding, filing or machining is required, the entire production capacity represents but 16 man-hours a day, or about 800 units per operator on each 8-hr. shift. Assembly is reduced to a minimum so far as labor is concerned, and every bit of material left over in gates and sprues can be reground and used again.

Many factors were taken into consideration when choosing a plastics material for this development. First, there could be no cold flow of material because the flange on the cap might deform and cause leakage. Second, the material had to be able to withstand all sorts of water which it might encounter in various parts of the country, without absorbing any moisture. Third, it had to withstand hot water without softening and cold water without becoming brittle. In Arizona and Texas, water lines frequently are laid only one foot beneath the surface of the ground because there is no danger from frosts, and in the summer this water becomes pretty hot. Contrast this with a factory toilet installation in Oregon or Maine where heat may be reduced to a minimum over week ends during minus-zero weather. In either instance, polystyrene behaves well.

The worst enemies of brass units are corrosion and scale which eventually destroy the unit or clog its working parts. Water frequently is chlorinated to make it potable, and chlorine is a natural enemy of metal, especially brass. Also there are many micro-organisms in water that cling to the rough surface of metals, building up an accumulation that sooner or later must be removed lest it interfere with working parts. Natural alkalies in water in many parts of the country attack metal and cause scale. The smooth glossy surface given polystyrene by the polish of the mold prevents organisms from getting a toe hold where they can build up. Each time the tank is discharged, these tiny particles are washed clear of the unit. Neither acids nor alkalies, in the mild form in which they may be present in water, will have any effect on polystyrene. And the plastic cannot rust or corrode. There is another interesting comparison between polystyrene and brass which may not be generally known. When there is pressure against a brass valve or when a tiny particle of dirt gets under the valve and causes it to drip, a definite groove may be worn in the metal valve seat causing it to leak. Although polystyrene is softer than bronze, it is resilient enough to give under such conditions, and no groove will appear.

(Please turn to next page)

Polystyrene was selected after a prolonged series of tests on identical units made of polystyrene, cellulose acetate, cellulose acetate butyrate and high acetyl cellulose acetate. The principal test in which the engineers were interested was one for resistance to cold flow under working load immersed in water. The test set-up consisted of a standard flush tank in which the ballcock was installed in the normal manner and the water level determined at regular intervals. Since small amounts of cold flow were reflected as relatively large changes in the water level, the tests were both practical and sensitive. All of the materials except polystyrene performed about alike. In every case the water level rose at the rate of about one-half inch per day over periods of one to five days. The polystyrene samples alone showed ability to hold the water level to the degree of constancy desired. As a further check, a sample "lever rod" of each material was mounted in such a way that it could be subjected to a load of approximately twice the normal operating load in service. This is equivalent to the force necessary to completely submerge the float ball. In a period of 24 hr., each of the rods, except the styrene, had taken a permanent set of from one to two inches. The styrene rod showed no measurable permanent set. It is interesting to note that all these tests were made in the same tank, but with water varying in temperature from 67 to 147° F., in order to meet summer conditions anywhere in the United States.

With allocation of polystyrene for this important replacement fixture, it soon will be on the market in sufficient quantities to prevent any breakdown in our system of sanitation. It will save tremendous quantities of copper and brass for more important applications. Once installed, it is likely to outwear any other ballcock ever made.

Credits—Material: Float ball, Lumarith. Ballcock, Bakelite polystyrene. Molded by Plastic & Rubber Products Co., for Pan-American Plastics, Inc.

Test program

(*Continued from page 158*) proximately two months inspecting facilities of numerous colleges and universities and interviewing members of the faculty. Many of the schools were ruled out because they were not in a position to handle additional work, being already greatly overloaded with strategic research projects. The following factors were given consideration before the final decision was made: facilities at the school, national reputation, available personnel and cost. By considering and weighing these several points the field was narrowed down to two or three schools.

There were two major factors which led to the selection of the Johns Hopkins School of Engineering as the test agency. The school is well situated geographically, and the services of Dr. Ralph K. Witt were available to the laminators. Dr. Witt has been conducting E.S.M.W.T. courses at the university, designed to train aircraft and electrical industry personnel in the application and use of plastics in their particular field. Dr. Witt has a Bachelor's degree in chemical engineering from the University of Virginia and a Ph.D. in physical chemistry from Johns Hopkins. He was a National Research Fellow at the University of California and had 18 months' work at the University of Berlin in the Physical Chemistry Institute. After spending 5 years in industry, he joined the Chemical Engineering Department at Johns Hopkins in 1937.

In order to satisfy the requirements of Questionnaire No. 2, the laminators felt it was necessary to appropriate a fairly large sum of money to purchase additional test equipment for Johns Hopkins. All of this equipment has not been secured due to priority restrictions, but by the end of this year the machinery should be in place and operating. Present activity at Johns Hopkins involves a training program to acquaint the personnel with plastic specifications and test methods. No agency could do a satisfactory job of testing the products of the laminated industry without this trial experience. Although the training period is not yet complete, production testing should be under way soon.

While this test agency originated with the need for concrete facts about laminate materials as applied to aircraft structures, now that the test program is in the process of development and has sufficient funds to carry it through to a conclusion, the industry should have available within a short time a complete set of data covering the structural requirements of its materials. In the operation of these experiments and from the results obtained during the balance of the emergency, the laminating industry will be able to evaluate the agency's efforts and determine whether or not such a program should be continued during peace time.

Looking into the future there are many functions which this testing program could fulfill for the laminating industry and its customers. In a degree it could serve as a policing agency to assist all Section members in keeping their products within existing specifications. It could serve to evaluate new materials reaching the market from individual manufacturers. The testing laboratory could standardize these new laminates and assist in writing specifications when the materials became standard in the industry. The Technical Committee of the Laminated Section in its dealings with Governmental agencies on specifications and with the American Society for Testing Materials, has been forced to make use of the facilities of its individual members. The test agency could save the industry much duplication and provide data less open to criticism and more representative of standard products. By reason of its authoritative source for test information, this project could serve the manufacturers of laminates by securing publicity for their products. Conversely, it could protect the industry from adverse publicity and against products not complying with accepted standards.

At the October 26th meeting of the Laminated Section held in New York City, the Johns Hopkins program was financed adequately for the ensuing year and appropriations were made for additional equipment. It is true, therefore, that the Johns Hopkins program now is on a basis whereby the Laminated Section is assured of being able to fulfill its responsibilities to Government agencies as to test information on its products. It is conceivable that this agency will be found sufficiently valuable so that the laminators will continue its existence indefinitely.

Pulp preforming

(*Continued from page 116*) is required. In general, it may be said that the preform tool must conform closely to the design of the finished article. Inasmuch as there are several variables affecting the deposit of the fiber on the preform tool, special care in its design must be exercised in order to reduce the necessity of more than nominal flow during the molding cycle. Contrary to the general impression, the time required to produce a preform in its original wet state is generally a matter of seconds rather than of minutes. For this reason a preform tool can be expected to produce many hundreds of preforms in a single day. The actual preforming time will vary with the section thickness, and the overall


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preforming cycle will depend to a large extent on the complexity of form.

Basically, the design of molding dies for resin-fiber products follows conventional practice. Usually, heat-treated steel dies having the usual steam channels and knockouts are used. The entering edge of the cavity, however, is usually modified to facilitate the entrance of the preform so as to reduce drag to a minimum. Recent improvements in die design have made it possible to mold resin-fiber products in solid dies which, upon removal from mold, have a negligible amount of flash.

The question of cost as related to resin-fiber products will naturally be influenced by several considerations. At the outset it must be remembered that resin-fiber plastics must be included in the class of high-strength plastic materials. Furthermore, it must be borne in mind that their principal field of application is in the realm of large-size pieces. A further influence on the cost of resin-fiber plastics is the resin content of the material. This usually ranges from 30 to 55 percent depending on the characteristics desired in the product. It can be stated as a generality that the cost of the preform ready for molding will range from about 10 to 30 cents per pound. Optimum cost will be reached, of course, when substantial molding runs are made.

While large pieces have been stressed throughout this article, it would be well to mention as an example of the extreme versatility of the resin-fiber process, that this company has produced several million diaphragms for use in communication equipment where the maximum molded thickness was only .003 inch. The minimum molded thickness on these diaphragms was slightly under .002 in., and the total allowable tolerance was ±.0002 inch. This is a special application which cannot be met satisfactorily by other molding processes. Inserts may be successfully incorporated in resin-fiber molding, subject to certain limitations. They may not be used with the freedom allowable in compression molded products due principally to the fact that a preform is used which very closely approximates the finished molded article and which permits only a limited, localized flow of the resins in the mold. Certain successful applications using relatively large inserts have been made.

In line with the general conviction that the resin-fiber method is particularly applicable to the manufacture of large molded pieces, this company for some time past has had a comprehensive program for the development of a more satisfactory technic of the bag molding principle. Several new approaches to the bag molding idea have been made. These include development of new elastomers for use in molding bag construction. While it is somewhat early to draw conclusions from this program, the results to date have been most promising. The resin-fiber development program initiated by the Hawley Products Co., several years ago is being worked out in close cooperation with the Monsanto Chemical Co., Plastics Div. Certain specific problems relating to the program are currently being studied at Mellon Institute of Industrial Research at Pittsburgh and at the Armour Research Foundation in Chicago.

Plastic conversion

(Continued from page 115) conversion must now be accompanied with proof that it is being made either to conserve strategic materials or for the purpose of improving the part or conserving the very precious man- and machine-hours, the following information was included in the above request.

"On a production of approximately 50,000 collars it is estimated that with this plastic conversion there will be a clear saving of approximately 12,000 man-hours and an equivalent number of machine-hours; it is also estimated conservatively that these savings can be multiplied 100 times or more were this substitution allowed on all contracts for this material."

Needless to say, when such facts were brought to the attention of the Bureau of Ships, the understanding of the importance of conversion from critical materials resulted in the cooperation of the head of the Electrical Design Division of the Bureau of Ships, Mr. Thomas E. Cassey. It was made clear to the Bureau that this plastic collar was so designed as to make it a completely universal replacement and, therefore, interchangeable and adaptable to any and all types of assemblies which had used the metal collar, except those made before the change.

Previous to this request for test, this lighting fixture company had proceeded at its own risk with the construction of a 9-cavity production mold which was conservatively estimated to produce approximately 1600 collars per day. A mold of this large capacity was decided upon with a view to having production available not only for this one fixture company, but for many other companies as well.

Authorization for this approval test was received promptly, and samples were transmitted to the Bureau. After successfully passing the Navy high-impact shock test as well as a one-hour high-frequency vibration test, official approval was given for the molded phenolic assembly to be used in lieu of the porcelain-enamel-steel parts. The production molds which had been ordered sufficiently in advance, were ready and waiting. Production began at once. At present these plastic parts are being used in standard Navy lighting fixtures.

No figures have been given as to the exact number of standard fixtures that are used on any of our fighting ships, but it is well known that the reduction of weight of a fighting ship above the water line is of prime importance. It is important to bear in mind, therefore, that for every thousand of these assemblies used above the water line, there is a direct weight saving of 300 pounds.

An official of the company has brought to light the fact that these fixtures are delivered to the shipyards completely assembled. Before installation they must be disassembled, wired and then reassembled. Due to the fact that the wiremen aboard ship now have but one part instead of three to disassemble, this plastic conversion is the direct cause of greatly speeding up shipboard wiring jobs. Another advantage which has caused a great reduction in the number of rejections both in the fixture manufacturer's plant and aboard ship is the fact that the plastic surface of the collar is not prone to crack or chip. The vitreous enamel coating previously in use on the metal collar had very definite cracking tendencies which resulted in a large number of rejects. This difficulty necessitated disassembling the old fixture, discarding the chipped collar and replacing it with a good part.

There has been much discussion with reference to the thousands of conversions which have permitted plastics to play such a large role in saving high strategic metals. Due to the versatility of these plastics and the multitude of uses which have been found for them, it has become incumbent upon all engineers to weigh carefully the reasons for using plastics and at no time to specify plastics unless their check sheet shows that these new materials do a better job or indicate important savings in man- and machine-hours.

Credits—Material: Bakelite. Molded: Mack Molding Co. for Lightolier Co.

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PLASTICS DIVISION

MOLDED MPC PRODUCTS

One-piece housing

(*Continued from page 104*) copper sheet-metal cover. The plastic housing eliminated an elaborate brass guard all around the delicate balance-arm and spring mechanism which served as a guide for the copper cover while it was being lowered onto the base. With the transparent cover the operator can see what is happening and can avoid striking delicate parts. The second advantage is of a psychological nature. It has been demonstrated that an operator will handle the gage more carefully if the workings of the delicate mechanism are always before him. The plastic cover also eliminates the danger of the balance-arm mechanism being damaged by an accidental blow by the cover on the pointer.

The phenolic knob, a stock mold product, has been a standard part since the instrument first was produced several years ago. It is used to turn a pinion which moves the gage vertically on the post so that samples of different sizes can be accommodated. Before conversion, the instrument base was made of brass. Weighing approximately 1$^1/_8$ lb., it required sanding, filing, drilling, spraying and baking. The blocks of laminated lignin plastic, which replace the metal bases, can be sawed to size. Following thorough sanding on a wet sander, the edges are beveled, and the hole which supports the upright post is drilled and counterbored with high-speed steel tools. A very thin coating of light machine oil permanently changes the color from dark brown to black. Each processing operation is much more rapid than in the case of the brass base. The acetate magnet guard is machined from a $^3/_8$-in. diameter rod. A second model, the extended-arm Magne-Gage, employs a methacrylate "proboscis" which is made from stock rod.

It is estimated that the redesign of these gages to permit the use of plastics has enabled the company to save 2$^1/_2$ lb. of brass and $^1/_3$ lb. of copper on every instrument it produces. In addition, approximately 4 man-hours have been saved on the production of each of these gages.

Credits—Cover: Tenite II, molded by American Insulator Corp., from dies of its own design. Knob: Molded by Kurz-Kasch. Base: Lignolite. Magnet guard: Macoid. Instrument manufactured by American Instrument Co.

Washington round-up

(*Continued from page 150*) supervisors or leadmen. Most effective results have been obtained in plants where management has given as much weight to training plans as to other production problems." As an aid to its program the WMC has just released a new bulletin prepared by its Bureau of Training under the title, "Training Women for War Work." The Bureau of Training also has compiled a series of reports from Regional Chiefs of Training which are assembled under the title, "Training Womanpower."

More Shellac Available for Military Purposes

Industrial chemists cooperating with WPB and Navy experts have developed several types of synthetic resin which will replace shellac for leading uses, the WPB has announced. Production of these resins has reached such sufficient volume that the Navy has transferred its large holdings of shellac to the Defense Supplies Corporation to be available to other departments for war purposes. In consequence, it is anticipated that larger quantities of shellac will be made available to industries which require this material to fill Army and Navy contracts. For some months the shellac requirements of these industries have been considered second in importance to the direct requirements of the Navy. Shellac for civilian uses probably will not be available unless India is able to supply greater quantities.

Military insignia

Military insignia containing plastic or metal may be produced only on orders or contracts originating in certain specified Government agencies or firms designated by the WPB in an amendment to Order L-131, according to a recent announcement. Under the previous order, production was unrestricted except for limitations on the use of materials. Distribution was controlled by restricting sale or transfer to authorized outlets only. Distribution of military insignia is not directly controlled under the newly amended order. The revised order permits the use of silver and copper in production of military insignia in accordance with WPB orders M-9-c, copper, and M-199 silver.

In the news

(*Continued from page 156*)

★ MORE THAN 100 MEMBERS AND GUESTS OF Detroit Section, Society of Plastics Engineers, attended the Nov. 12 dinner meeting in Rackham Memorial in Detroit. William B. Hoey, president, gave a brief report on the October convention and announced the decision of the section to give $500 to Wayne University rubber-plastics project to go toward purchase of laboratory equipment badly needed at the present time.

In the absence of Bart Batty, program committee chairman, L. J. Morrison introduced the 2 speakers of the evening—George Grees, Detroit representative, Monsanto Chemical Co., who spoke on "Plastics on the Path of War and Plastics on the War Path;" and Dr. Ralph L. Lee of the public relations department, General Motors Corp., who discussed problems of employee relations.

Mr. Grees said that it is logical to expect that scores of the developments that have come with the war will find peacetime applications which never were anticipated. He stressed the fact that the plastics industry no longer was young in the sense that it could use immaturity as an excuse for failure to meet the requirements of a situation. In his opinion the war has produced and the industry has learned to use, new materials for which it still lacks the necessary mechanical handling equipment. This was interpreted to mean that the product development must wait or be restricted until new machinery is available.

Dr. Lee characterized employee relations as the most pressing and immediate problem confronting industry today. In his opinion men form the neck to the bottle. American industry still is forced to use the cut-and-try methods for dealing with its manpower. The need is for facts, Dr. Lee said. He then explained the operation of his "facts pool," a collection of notations on employee relations submitted by successful factory supervisors whom he has contacted. Among the outstanding facts emerging from this research is the point that everyone is different—one of a kind. In view of this fact, Dr. Lee said that industry should not expect any general set of rules to prove equally effective with all individuals. Another important fact emerging from his research is that people are what they are because they cannot change or be changed very much. In addition, he has discovered that no one individual is the same all the time. A fourth fact cited as outstanding in this human relationships in industry study, is the pride of "being different."

★ THE CHEMICAL PATENTS AND PATENT APPLIcations vested by the Alien Property Custodian have been abstracted by the Chicago Section, American Chemical Society, and now are being indexed by a committee of the Science and Technology Group, Special Libraries Association. Beginning in Jan. 1944, these abstracts will be published in 31 classified, indexed pamphlets to be followed by a master index and a supplement of new abstracts. The prices, if demand is adequate to justify them, will be one dollar for any booklet and $25 for all 33 booklets.

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FOR SALE: Watson-Stillman Hydr. Presses, 12" x 12" Platens, 7½" Ram: 22" x 24", 5½" Ram: 25" x 36", two 5" Rams: 48" x 26", four 3½" Rams: 78" x 36", two 7½" Rams. Robertson 13" x 16", 8" Ram. 400 Ton Hydraulic Extrusion Press. W. S. Hydro-Pneumatic Accumulator. W. & P. 150 gal. jacketed Mixer. Faust 150 gal. heavy Double Spiral Jack. Mixer. 7 Brand new Ball & Jewel Premier Rotary Cutters. Large stocks of Hydraulic Presses, Pumps, and Accumulators, Mixers, Grinders, Pulverizers, Gas Boilers, etc. Send us your inquiries. We also buy your surplus machinery. Stein Equipment Co., 426 Broome St., New York City.

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Men with plastic sales experience may also apply. Box 862, Modern Plastics.

WANTED

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Box 863, Modern Plastics

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Top Flight Man—Excellent sales record Metropolitan area. Past 3 years employed as Product Engineer Large Custom Molder. Knows all phases Compression and Injection Molding. Constructive Post-War plans. Seeks representation custom molder New York Area. Age 43—Married—Can furnish certificate of Availability. Reply Box 890, Modern Plastics.

MECHANICAL DRAFTSMAN—Technical education, draft status 4-F. Seven years steel mill experience as machinist, metallurgical laboratory assistant and draftsman. Possesses ingenuity and artistic creativeness. Desires position as designer and draftsman with concern normally engaged in devising and producing plastic household and industrial equipment. Desires position with aggressive concern promising post-war employment. Box 891, Modern Plastics.

WANTED: A PLASTIC EXTRUSION MACHINE preferably a 2½" National. Will make an attractive offer. Reply Box 892, Modern Plastics.

CHEMIST AND PRODUCTION SUPERVISOR. Well established, textile coating firm located Brooklyn, N. Y., requires the services of a chemist thoroughly familiar with formulating of plastics and synthetic resins. A good knowledge of textile coating procedure including preparation of coating compounds and their application to cloth is essential. Excellent opportunity. Permanent. Write fully stating age, experience and salary. Box 893, Modern Plastics.

WANTED PLASTIC COMPOUND

or formula for cold molding-casting. None priority unbreakable, short setting time. Flexible molds are to be used. Box 894, Modern Plastics.

CHEMICAL ENGINEER WANTED

Opportunity to lead sales development of plastics in electrical and textile fields. Responsible and permanent position. Headquarters, New York.

Write, stating background and qualifications.

Box 895, Modern Plastics

WANTED

PLASTIC MOLDING PLANT

in N. Y. Metropolitan area . . . We are in the market to purchase a plastic molding plant to produce a new product and will give you quick action if you have the equipment we need. Write fully in confidence. Box 896, Modern Plastics.

OPPORTUNITY WANTED
Young man 35 years of age honorable discharge from army excellent health has had 13 years experience as head distributor for one of the largest shoe organizations in the country, is interested in the Plastic Industry. Will undergo any period of training that will eventually lead to something substantial in this industry. Salary is secondary to opportunity. Box #220, Modern Plastics.

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